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JOURNAL OF ETHNOBIOLOGY

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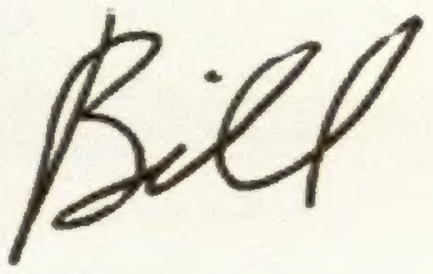
ETHNOBIOTICA

The Journal of Ethnobiology is its articles, book reviews, features, and other matter found between the covers of each issue, front to back. It is more, of course, than a paper product, though. The journal has for two decades served as a vehicle for disseminating basic research, carried out from a variety of perspectives on an even broader geographic and temporal scale, into the relations among people, flora, and fauna. The authors of articles published in the journal have all had the advantage of seeing their work evaluated through a sometimes painful but mostly indispensable and excellent peer-review process. Now, the authors and their articles that have appeared in this journal, from the first issue of the first volume through the last issue of volume 19, are cross-listed in the fine index to articles prepared by Michael Thomas of the University of Florida. That index, inside its own covers, accompanies this issue. It is the first index of the journal, and on behalf of the Board and myself, I thank Michael Thomas for his donation of time and expertise to this instrumentally useful project.

The editorship of the Journal of Ethnobiology clearly cannot be a one-person responsibility, as my predecessors also have known quite well. It involves a team effort par excellence; whatever success the journal may display in carrying out its scholarly mission must be owed to the individual players on that team. They are the authors, of course, whose names reside above their written outputs, as published herein. And the players include peer reviewers of manuscripts, coordinators of reviews, translators of abstracts, and others who have provided sundry assistance in editorial matters. It is opportune to acknowledge those players who have donated their time, energy, and expertise specifically to the publication of volume 19 and this, the first issue of volume 20 (i.e., the issues published since I became editor in May 1999). First, I thank the reviewers and coordinators of reviews, some of whom prefer anonymity. The others are: Karen Adams, Edward Anderson, Eugene Anderson, Alejandro d'Ávila, Tim Bayliss-Smith, Brent Berlin, Cecil Brown, Paul Buell, Robert Bye, Javier Caballero, Alejandro Casas, Iris Engstrand, Nina Etkin, Gayle Fritz, Jaap Harden, David Harris, Terry Hays, Eugene Hunn, Timothy Johns, Leslie Main Johnson, Elaine Joyal, Heidi Lennstrom, W. Litcinger, Brien Meilleur, Madonna Moss, Gary Nabhan, Debby Pearsall, Darrell Posey, Amadeo Rea, Paul Richards, Wendy Townsend, Nancy Turner, and Yunxiang Yan.

In addition, I gratefully acknowledge Adeline Masquelier for translation into French and Monica Miranda for translation into Spanish of English abstracts. Appreciation is due Anne Totoraitis of Publications Services, University of Washington, for expert advice on production matters and to Meredith Dudley of Tulane University for tireless and efficient editorial assistance. And I am grateful to Dr. Teresa Soufas, Dean of the Liberal Arts and Sciences of Tulane University, for making available funds that have been used in supporting aspects of the editorial and publication process here. I can verify that the team is moving the journal down field. Together, as we get closer to the destination of being on schedule, I hope that you, faithful reader, can join me in recognizing that diverse, individual efforts constitute the essence of this journal.



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MATSES INDIAN RAINFOREST HABITAT CLASSIFICATION AND MAMMALIAN DIVERSITY IN AMAZONIAN PERU

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ABSTRACT.– The Matses Indians of northeastern Peru recognize 47 named rainforest habitat types within the Gálvez River drainage basin. By combining named vegetative and geomorphological habitat designations, the Matses can distinguish 178 rainforest habitat types. The biological basis of their habitat classification system was evaluated by documenting vegetative characteristics and mammalian species composition by plot sampling, trapping, and hunting in habitats near the Matses village of Nuevo San Juan. Highly significant ($P<0.001$) differences in measured vegetation structure parameters were found among 16 sampled Matses-recognized habitat types. Homogeneity of the distribution of palm species (n=20) over the 16 sampled habitat types was rejected. Captures of small mammals in 10 Matses-recognized habitats revealed a non-random distribution in species of marsupials (n=6) and small rodents (n=13). Mammal sightings and signs recorded while hunting with the Matses suggest that some species of mammals have a sufficiently strong preference for certain habitat types so as to make hunting more efficient by concentrating search effort for these species in specific habitat types. Differences in vegetation structure, palm species composition, and occurrence of small mammals demonstrate the ecological relevance of Matses-recognized habitat types.

Key words: Amazonia, habitat classification, mammals, Matses, rainforest.

RESUMEN.– Los nativos Matsés del nordeste del Perú reconocen 47 tipos de habitats de bosque lluvioso dentro de la cuenca del río Gálvez. Combinando sus designaciones vegetativas y geomorfológicas de habitats, los Matsés pueden distinguir 178 tipos de bosque. La base biológica de su sistema de clasificación de habitats fue evaluada documentando características vegetativas y composición de especies de mamíferos por medio de medir vegetación en parcelas, atrapar con trampas, y cazar en habitats reconocidos por los Matsés cerca de la comunidad nativa Matsés Nuevo San Juan. Se encontró diferencias de alto significado ($P<0.001$) en los medidos parámetros de estructura de vegetación entre los 16 tipos de habitats que fueron muestreados. Homogeneidad en la distribución de especies de palmeras (n=20) en los 16 tipos de habitat fue rechazado. Capturas de mamíferos pequeños en diez habitats reconocidos por los Matsés reveló una distribución no-aleatoria en las especies de marsupiales (n=6) y roedores pequeños (n=13). Mamíferos vistos y señales de mamíferos apuntadas durante cazas con Matsés sugieren que algunas

especies tienen preferencias para ciertos tipos de habitats reconocidos por los Matsés que son suficientemente fuertes para que la caza sea más eficiente cuando se concentran esfuerzos de busca en específicos tipos de habitat. Diferencias en la estructura de vegetación, en la composición de especies de palmeras, y en la existencia de mamíferos pequeños demuestra la pertinencia ecológica de estas unidades.

RÉSUMÉ.– Les matses, un groupe amérindien du nord-est du Pérou, reconnaissent 47 types d'habitats (pour lesquels ils disposent de termes spécifiques) de la forêt tropicale dans le bassin hydrographique du fleuve Gálvez. En combinant ces termes pour les différents habitats végétaux et géomorphologiques, les matses arrivent à distinguer 178 types d'habitats. La base biologique de leur système de classification a été évaluée en documentant des caractéristiques de la végétation et des espèces de mammifères à travers l'examen de la végétation dans certaines parcelles-échantillons, la chasse et la prise en piège dans les habitats reconnus par les matses près du village matses de Nuevo San Juan. Des différences très significatives ($P<0.001$) ont été trouvées dans les paramètres structurels mesurés pour la végétation dans les 16 types d'habitats où des échantillons ont été pris. L'hypothèse d'une distribution homogène des espèces de palmiers (n=20) pour les 16 types d'habitats a été réfutée. Des captures de mammifères de petite taille dans dix habitats reconnus par les matses a révélé une distribution non-aléatoire des espèces de marsupiaux (n=6) et de petits rongeurs (n=13). Des mammifères et des signes rencontrés lors des expéditions de chasse avec les matses suggèrent que certaines espèces de mammifères ont une préférence suffisamment marquée pour certains types d'habitats reconnus par les matses pour que la chasse soit effectivement plus productive si les efforts sont concentrés sur ces habitats. Des différences concernant la structure de la végétation et la composition des espèces de palmiers, ainsi que l'existence de mammifères de petite taille, démontre l'importance écologique des ces unités.

INTRODUCTION

The ongoing deforestation of the Amazon rainforest presents an urgent need to document its diversity and understand underlying ecological processes. Though it is widely recognized that high species richness in tropical rainforests is associated with habitat heterogeneity, the patterns of habitat diversity within rainforest areas are poorly understood. Vegetation classifications of Brazilian Amazonia based primarily on flooding regimes, water quality, geographic location, and non-forest habitats within the Amazon basin (e.g., Pires 1973; Prance 1978, 1979; Braga 1979; Pires & Prance 1985) are useful for understanding variation on a large scale, but they are not sufficiently detailed to describe habitat types present in a small locality. The classifications of Malleux (1982) and Encarnación (1985, 1993), which are derived from the knowledge of foresters and local residents, respectively, are more detailed and thus more sensitive to variation within large habitat classes. However, these classifications were designed for comparison of habitats throughout the Peruvian Amazon, and still lack detail, especially for *terra firme* habitats. Descriptions of successional stages, initiated yearly by the deposition of sediments along large rivers (e.g., Salo et al. 1986; Lamotte 1990; Kalliola et al. 1991; Campbell et al. 1992), related well to habitat variation on a small scale, but these descriptions

are not applicable to upland rainforest, which covers the vast majority of Amazonia (approximately 85 percent [Prance 1978]).

Some indigenous peoples of Amazonia have extensive knowledge of rainforest communities. This knowledge is reflected in detailed habitat classifications (e.g., Carneiro 1983; Parker et al. 1983; Posey 1983; Alcorn 1984; Posey and Balée 1989; Balée 1994; Shepard et al. in press) which have potential for use in conjunction with scientific surveys, particularly in rapid assessment of rainforest communities for conservation. A case in point is the rainforest habitat classification system of the Matses Indians of Northeastern Peru.

The Matses (also called Mayoruna; Panoan language family) are an indigenous Amazonian society consisting of about 1500 persons living along the Javari River and its tributaries in Peru and Brazil (Figure 1). In 1969 the Matses established peaceful contact with Summer Institute of Linguistics personnel (Vivar 1975), although they reportedly had intermittent contacts with rubber workers between 1920 and 1930 (Romanoff 1984), and it is possible that as early as the fifteenth century some of their ancestors may have been reduced in missions to the east of their present territory (Erikson, 1994). Prior to 1969, the Matses avoided contact by maintaining hostile relations with neighboring non-tribal Peruvians and Brazilians, and by staying far from navigable rivers in the area between the Javari and Ucayali Rivers, and to the east of the Javari (Romanoff 1984). In the 1980's some groups moved away from the inland villages and settled on the banks of the Yaquerana (Upper Javari) and Gálvez Rivers. Acculturation of the Matses to the national culture is proceeding rapidly, but because of their recent isolation, older individuals (>30 years of age) still possess undiminished traditional knowledge.

The Matses meet all their nutritional needs through traditional subsistence activities, including hunting, fishing, trapping, horticulture (primarily manioc, plantains, and corn), and collection of wild foods. They continue to procure the majority of their protein from hunting in upland forests for mammals and birds. The Matses use an elaborate system of rainforest habitat nomenclature and classification to organize their knowledge of resource availability in order to conduct and discuss their subsistence activities more effectively. Their system allows them to identify as many as 104 types of primary rainforest and 74 types of secondary (successional) rainforest within the 8000-km^2 drainage basin of the Gálvez River.

Such narrow definitions of habitat types in Amazonia have limitations, and local plant species composition might be better characterized by broad descriptions of soil and hydrology gradients (Kalliola et al. 1993). However, we present the Matses system as a complementary tool for describing Amazonian habitat diversity, particularly in light of the utility of systems of categorization for establishing conservation policy. The Matses knowledge of rainforest habitats holds potential for description of ecological relationships as well as floristic diversity, considering that some Amazonian animals are known to be largely restricted to minor habitat types; for example, collared titi monkeys (*Callicebus torquatus*) are habitat specialists in creekside forests (Peres 1993) and ichthyomyine rodents are almost never found away from bodies of water (Voss 1988).

This study was designed to provide preliminary biological descriptions of Matses habitat types and to investigate the extent to which Matses habitat designations reflect quantifiable biological factors. To evaluate the ecological basis of

Matses habitat classification, we sampled 16 Matses-recognized habitat types that occurred within a 2 km radius from the Matses village of Nuevo San Juan in northeastern Peru. The objectives of this study were: 1) to describe the Matses system of rainforest habitat identification and classification; 2) to evaluate if Matses-recognized habitat types exhibit distinctive vegetation characteristics with measurements of vegetation density, basal area, and palm species composition; 3) to ascertain if Matses-recognized habitat types exhibit different small mammal composition and abundance with data obtained through systematic trapping; and 4) to see if mammals observed while hunting with the Matses exhibited differential use of Matses-recognized habitat types.

STUDY SITE

The study area was located along the Gálvez River (a tributary of the Javari River) at the Matses village of Nuevo San Juan (73°9′50"W, 5°17′30"S, 150 m above sea level), in the district of Yaquerana, department of Loreto, in northeastern Peru

FIGURE 1.– Location of Nuevo San Juan study site in northeastern Peru, showing the Gálvez River drainage basin.

(Figure 1). Average annual rainfall (2900 mm) and average annual temperature (25.9°C) were recorded at Jenaro Herrera, the location of the nearest weather station, 100 km west of Nuevo San Juan (Marengo 1983). The period of heavy precipitation extends from late December through mid April; July and August are the driest months. The Gálvez is a blackwater river with a narrow floodplain that seldom extends more than 0.5 km on either side. Although the dry season is not exceptionally dry, the water level in the Gálvez falls impressively, a total of 10 m from April to August.

The area around Nuevo San Juan is primary ("virgin") rainforest except for gaps caused by windfalls and active and abandoned swiddens (0.5-2 ha horticultural plots) that have been cleared since the village was established in 1984. At the time that the Matses moved into the area, no villages had existed in the lower reaches of the Gálvez for at least 25 years (Faura 1964). Woodroffe (1914), who visited the lower Gálvez in 1905-6 reported that there was apparently no human habitation in the area except for a handful of rubber workers. None of the Matses who were interviewed recall there ever having been inhabitants in the Gálvez drainage basin other than at the very headwaters. The Matses recognize some rainforest areas within the Gálvez basin that they identify as villages or swiddens of other tribes through the presence of pot shards, indicator plant species, such as the palm *Elaeis oleifera*, or distinctive vegetation structure; however, no such areas exist within a day's walk from Nuevo San Juan, and so the Matses consider all areas surrounding Nuevo San Juan that were not cleared by them or are visibly the result of a windfall to be primary forest. And we were not able to detect any areas around Nuevo San Juan that appeared to be advanced successional forest (but see Balée [1989] for the possible anthropogenic nature of apparently primary forests in Amazonia). The habitat classification system here includes only rainforest habitats, and so we did not consider beach vegetation or active Matses swiddens, which the Matses classify into at least three types based on the age and/or crop composition of the swidden.

According to Matses informants, over the last 12 years abundance of some game animals has declined and densities of species adapted to secondary forest, such as agoutis (*Dasyprocta fuliginosa*; see Appendix C for mammal species authorities) and pacas (*Agouti paca*), have apparently increased; however, there is no evidence of extirpation of any species from the area.

METHODS

The data for this study were collected during two field seasons totaling 18 months from 1994 to 1996. From April to July 1994, twelve men from the Matses villages of Nuevo San Juan, Remoyacu, and Buen Perú were individually interviewed about the different habitat types that they recognized. An initial list of Matses names of rainforest habitat types was compiled from interview responses about the natural history of the local mammal fauna (Fleck 1997). Later, informants were asked to list as many rainforest habitat names as they could and to describe them, and then to comment upon habitats listed by other Matses informants. Subsequently, the informants were asked how they identified and classified these habitats and about the ecological relationships between mammals and these

habitats. Only those habitat names that the Matses listed without my help were recorded in the initial listing, but when asked to describe habitats, they were also asked about habitat types mentioned by other informants. Interviews lasted from about 0.5 to 1.5 hours and were carried out without any other adults present. Trade items were exchanged for interviews, but these were given to informants prior to conducting the interview in order to make it clear that receiving the item did not depend upon the nature of their answers. While accompanying Matses on hunting trips, they were asked to name habitats that we passed through and to explain what characteristics they used to recognized them. It is from these interviews and consultations that the final list of habitats was compiled. Habitat type names that were mentioned by only one informant or that were rejected as valid habitat types by more than half of the informants are not included in this paper.

Sixteen Matses-recognized rainforest habitat types (hereinafter, habitat types) that exist within a 2-km radius of Nuevo San Juan were selected for vegetation sampling. The goal of the habitat comparisons in this study was to determine if the basic classification units (named habitat types) of the Matses system were ecologically relevant units. The purpose of our sampling design was not to provide a complete floristic or structural description of each habitat type, but rather to determine if Matses-recognized habitats could be distinguished one from another with data from limited sampling.

From April to July of 1996, eight 0.02-ha vegetation sampling plots (10 x 20 m) were established within each of the 16 habitat types by randomly selecting a starting point and a compass bearing for orientation of the plot. Two to four separate localities of each of the 16 habitat types were sampled; the number of plots per locality was related to the size of the habitat patch. At each plot, eight vegetation density estimates were conducted by using a 1 x 1 m density board marked with a 10 x 10 (10 cm) grid. The board was placed on the ground in a vertical position at a distance of 5 m from the observer and the number of squares more than 50 percent covered by vegetation were counted for the bottom half of the board and again for the top half. Diameter at breast height (DBH; 1.3 m) was measured for each tree within each plot; trees with stilt or buttress roots reaching above 1.3 m were measured just above the roots. From the DBH measurements, mean basal area per ha and mean number of trees >10 cm DBH per ha were calculated for each habitat type.

All identifiable palms (Palmae; palm nomenclature follows Henderson et al. 1995) taller than 1 m were identified and counted within each study plot. Palms were selected for study because they are salient, readily identified components of most Amazon rainforest habitats (Kahn et al. 1988), because Palmae is probably the most economically useful Neotropical plant family (Balick 1984), and because palm fruits and seeds are also important resources for rainforest animals (Zona & Henderson 1989). Other plant species that the Matses indicated as important for identifying habitats were quantified at each plot: the number of *Cecropia* spp. (Moraceae) trees taller than 1 m, the number of *Duroia hirsuta* (Poeppig. & Endl.) Shumann (Rubiaceae) trees taller than 1 m, and the number of lianas >1 cm DBH. The following geomorphological data were also recorded at each plot: distance from the river (during highest water level), relative elevation (estimated elevation above lowest land within 50 m), perceived quality of drainage (during the dry

season), and water regime (maximum number of days a plot remains inundated). Duplicate sets of voucher specimens were deposited at the Instituto de Investigaciones de la Amazonia Peruana herbarium in Iquitos, Peru, at the herbarium at the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos in Lima, and at the New York Botanical Garden.

Two dichotomous keys were constructed for identification of Matses-defined habitats in the Nuevo San Juan area, one for geomorphologically-defined habitats and one for vegetatively-defined habitats (Appendices A and B). These keys were developed based on habitat characteristics used by the Matses in teaching DWF how to identify habitats.

Ten of the 16 selected habitat types and a Matses manioc swidden were trapped for small (<1 kg) mammals. The aim of this trapping was not to describe the entire mammalian composition of each habitat or to test for differences in composition with the surrounding habitat, but to determine if the sampled habitats exhibited detectable differences in small mammal composition. At each of the 10 habitats, 30 Sherman live traps, 10 Tomahawk live traps, 40 Victor rat traps, 10 Museum Special snap traps, five pitfall traps with drift fences, and five Matses-constructed deadfall traps (total of 100 traps) were set at each habitat type for 10 nights (total of 1000 trapnights). Traps were spaced evenly over a 1-ha area within each habitat type, at least 10 m away from the edge of the habitat, with half of the Sherman, Victor, and Museum Special traps set 0.5 to 2.5 m above the ground. Two of the eight 0.02 ha vegetation sampling plots were established within each trapping plot. Traps were baited every afternoon with ripe plantain (except for deadfall traps, which were baited with manioc) and checked in the morning. All animals were identified and removed; voucher specimens were prepared for all species and from all animals with questionable identification. Because the number of traps was limited, the 11 areas were not trapped simultaneously, but rather one or two at a time successively over a period of 90 d (20 April to 18 July 1996), a period that coincides with the end of the rainy season and the beginning of the dry season. Voucher specimens are deposited at the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos in Lima, and at the American Museum of Natural History in New York.

From April 1995 to July 1996, DWF accompanied Matses on 108 hunting trips for a total of 583 h. The habitat types in which mammals were encountered during each hunt were recorded; two habitat names were recorded for each locality of observation, one for the vegetatively-defined habitat type and one for the geomorphologically-defined habitat type. The location and habitat of signs of mammals, including tracks, dens, beds, scat, and scrapings were also recorded when the sign could be confidently identified to species with the help of Matses.

In order to determine if the frequency of observations of mammalian species per habitat was different than expected by random distribution, the amount of time spent by Matses hunting in each habitat type was estimated by pacing Matses hunting paths for a total distance of 10 km, recording the points at which habitat types began and ended. Pacing data were then mapped by application of a global positioning satellite receiver (Figure 2). Vegetatively- and geomorphologically-defined habitats were calculated separately. Although the sections of the Matses hunting paths that were paced might not represent a random sample of the habi-

tats that the Matses cover on long hunting trips, the path-length estimates provide a rough estimate of the proportion of time that the Matses spend in each habitat type while hunting. Because Matses concentrate search time and hunting effort in selected habitat types, depending on the target species, sampling was not random during hunts. Therefore, these data were not subjected to statistical analysis. Also, this part of the study was not designed to test any mammal-habitat associations put forward by the Matses.

FIGURE 2.-- Geomorphologically-defined (shaded or patterned) and vegetatively-defined (outlined in white) habitat types in the Nuevo San Juan area, showing overlap of the two classification systems.

Vegetation densities, basal area and tree density were compared among the 16 sampled habitat types with one-way ANOVA tests and Tukey multiple comparisons. A Pearson Chi square test was used to test homogeneity of palm species abundances over the sampled habitats. All data recorded at each plot were used to construct classification and regression trees (CART; Brieman et al. 1984). CART analyses were used to see if Matses-recognized habitat types could be predicted using the measured habitat parameters. Three classification and regression trees were constructed, one for the eight sampled vegetatively-defined habitat types, one for the eight sampled geomorphologically-defined habitat types, and one for all 16 sampled habitat types. The dichotomous habitat keys were then compared with the classification trees to see if the two methods produced similar results and to determine if the same habitat characteristics were important distinguishing factors in both. Small mammal species diversity and abundance in the 10 trapped rainforest habitats and one swidden were analyzed using a chi-square test for homogeneity of the distribution of animals (at three levels, family Didelphidae, family Echimyidae, and family Muridae) across the 11 habitats. Exact nonparametric conditional inference was used since the trapping data were sparse--there were many zero values for the number of animals of a species captured in a habitat, making large sample methods invalid.

RESULTS AND DISCUSSION

The Matses recognize 40 named categories of primary rainforest habitats (of which 38 are terminal categories) and seven named categories of secondary rainforest habitats within the 8000-km^2 drainage basin of the Gálvez River (Table 1). The Matses use different names for floodplain habitats while they are inundated during the rainy season, but these were not counted as different habitat types in this study (Figure 3). The Matses habitat classification system is divided into two separate (but physically overlapping) subsystems: 1) geomorphologically-defined habitat types; and 2) vegetatively-defined habitat types (Figures 2-4).

Vegetation density varied significantly among the 16 sampled habitat types. One-way ANOVA tests revealed highly significant ($P<.001$) differences for vegetation density among 16 Matses-recognized habitat types, for both vegetation density below 0.5 m ($F=58.90$; Figure 5A) and from 0.5 m to 1 m ($F=65.52$; Figure 5B). Similarly, one-way ANOVA tests revealed highly significant ($P<0.001$) differences for basal area ($F=10.41$; Figure 5C) and for tree density ($F=9.06$; Figure 5D) among the 16 sampled habitat types, though these characteristics were considerably less distinctive than was vegetation density. Significant differences among habitat types in the measured vegetation structure parameters indicate that habitat types are related to vegetation structure and, therefore, of interest for ecological investigation. Moreover, pairwise comparisons of each habitat with each of the other 15 habitats revealed significant differences ($P<0.05$ Tukey's pairwise comparisons) in at least one of the four measured vegetation structure parameters in all but three of 28 pairs of geomorphologically-defined habitats and in all but five of 28 pairs of vegetatively-defined habitats. For pairs of geomorphologically- and vegetatively-defined habitats, a higher proportion (12 of 64) did not differ significantly (at 95% C.I) in at least one vegetation structure parameter; however, some

TABLE 1.– Forty-seven named categories of rainforest habitat types recognized by the Matses within the Gálvez River drainage basin in northeastern Peru. The Matses classify habitat types according to criteria of two major types: 1) geomorphological features, and 2) vegetation characteristics. The most important dichotomy in the Matses classification system is between floodplain rainforest along seasonally flooded rivers and upland rainforest that is not subjected to seasonal flooding. Matses also distinguish between primary rainforest and successional habitats. Numbers refer to habitat types sampled in this study and are used in subsequent tables and figures. See Appendix D for linguistic description of Matses habitat terminology.

HABITAT TYPES DEFINED BY GEOMORPHOLOGICAL FEATURES		
	mananucquio	Upland Rainforest
1	***quiusudquid***	Non-flooding forest adjacent to a river
2	***manan***	Hill crest (also called ***manan dadanquio***)
	macuësh	Hill incline (also called ***macuësh potsen***)
	tsimpiruc	Valley between upland hills
	acte dada cuëman	Gallery forest along a large stream
	acte cuidi cuëman	Gallery forest along a small stream
3	***dëpuen***	Ephemeral headwaters of a stream
4	***mactac***	Poorly-drained muddy mineral lick
	itia*	Upland palm swamp
	anshantuc	Permanently waterlogged swamp
	acte cuëman	Floodplain
5	***actiacho***	Low seasonally flooded forest (called ***acte mauan*** during flooding season)
6	***nacnëdtsequid***	Levee flooded every year
7	***mantses***	Levee flooded only on years of exceptionally high water levels (called **mashcad** during flooding season)
	chian cuëman	Forest along a floodplain lake
	acte mactac	Mineral lick in floodplain forest
8	***itia dapa****	Floodplain palm swamp (called **itia mauan** during flooding season)
HABITAT TYPES CHARACTERIZED BY VEGETATION CHARACTERISTICS		
	nimëduc*$_1$*	Primary Rainforest
	isanchoed	Forest dominated by *Oenocarpus bataua* palms
	nistechoed	Forest dominated by *Iriartea deltoidea* palms
	shuinte mapichoed	Forest dominated by *Attalea tessmanii* palms
	budëdchoed	Forest dominated by *A. butyracea* palms
9	***miochoed***	Forest with understory dominated by *A. racemosa* palms
10	***budëd ushuchoed***	Forest with understory dominated by *A. microcarpa* palms
11	***shubuchoed***	Forest with understory dominated by *Phytelephas macrocarpa* palms
12	***tanacchoed***	Forest with understory dominated by *Lepidocaryum tenue* palms
	dapaischoed	Forest with understory and midstory dominated by *A. phalerata* palms
	cobisanchoed	Swamp dominated by *Euterpe precatoria* palms
	tiantechoed	Forest dominated by bamboo
	sëntechoed	Forest dominated by *Cedrela* sp. trees
	pëncadchoed	Forest dominated by ***pencad*** trees
	manipadachoed	Forest dominated by *Musa* sp. wild bananas

13	***mayanën sebad***	Forest with open understory, dominated by *Duroia hirsuta* trees
14	***isitodochoed***	Forest dense with many large lianas
	cuëte mampis	Forest where only thin hardwood trees grow
	antinchoed	Seasonally flooded forest dominated by *A. maripa* palms
	sinadchoed	Seasonally flooded forest with understory dominated by *Bactris* cf. *bifida* palms
	shiuishchoed	Seasonally flooded swamp forest dominated by *Ficus* spp.
	cana shëtachoed	Low floodplain adjacent to the river with dense thorny vegetation
SUCCESSIONAL HABITAT TYPES		
15	***tied shëni***	Secondary forest in abandoned Matses swiddens dominated by *Cecropia* spp. and *Marila* spp.
	mayun tied	Secondary forest from abandoned swiddens or villages > 50 yr old
	cuesbudaid	recent blowdown characterized by creeping vines and no trees
	isitodo icsachoed	Secondary forest thick with vines and young trees
	bucuchoed	Secondary forest dominated by *Cecropia* spp.
16	***sedquequid******	Secondary forest from blowdown or river shift with many vines and few *Cecropia* spp. trees
	cuëteuidquio tabadquid	Secondary forest where hardwood trees are out competing pioneer vegetation and vines

* ***itia*** and ***itia dapa*** are included in both classifications, since they are defined by permanently waterlogged soil as well as being dominated by *M. flexuosa* palm trees

*****nimëduc*$_1$ in the general sense refers to all primary rainforest; in the specific sense (***nimëduc*$_2$) it refers only to primary rainforest habitat that does not fall under any of the other named categories

******sedquequid*** is also used to refer to a *chamizal* (Encarnación 1993), primary forest found on sandy soil where all trees are short and thin. The only *chamizal* in Matses territory is outside the Gálvez drainage basin, far from Nuevo San Juan.

of these pairs were not expected to differ because they often overlap physically in nature.

Twenty species of palms were identified in the sampled plots of the 16 habitat types. Genera that could not be identified with confidence to species in the field (*Geonoma* and *Bactris*) were excluded from analyses. The null hypothesis of homogeneity of the distribution of palm species over the habitats was rejected by the Pearson Chi-square analysis. In fact, some species of palms were present in 100 percent of the eight sample plots of some habitat types and absent in nearly all plots of other habitat types (Table 2; Figure 6). This is not surprising considering that Matses recognize and name many of their vegetatively-recognized habitats after palm species (see Appendix D for linguistic analysis of habitat names). Habitat types that had 100 percent frequency of occurrence of a palm species also had relatively high mean densities of that palm species.

Matses-perceived habitat types could be predicted with classification and regression trees using the measured variables. The classification and regression trees (CART) analysis of the eight geomorphologically-defined habitats correctly classified all (N=64) of the sample plots into their Matses-recognized habitat type

(Figure 7A). In the case of the eight vegetatively-defined habitat types, only four out of 64 sample plots (6.25%) were incorrectly classified (Figure 7B). When all 16 habitats were analyzed simultaneously, 12 of 128 (9.375%) were misclassified (i.e., the CART analysis categorized 12 plots differently than the Matses did). The CART analyses produced trees that were similar to the dichotomous identification keys developed using Matses information (Appendices A and B), with many nodes at the same positions.

The 10 sampled habitats revealed differences in small mammal species composition (Table 3), as well as species richness and abundance (Figure 8). The chi-square test for homogeneity of the distribution rejected the null hypothesis of homogeneity, indicating that the distribution of small mammals varies among the habitat types.

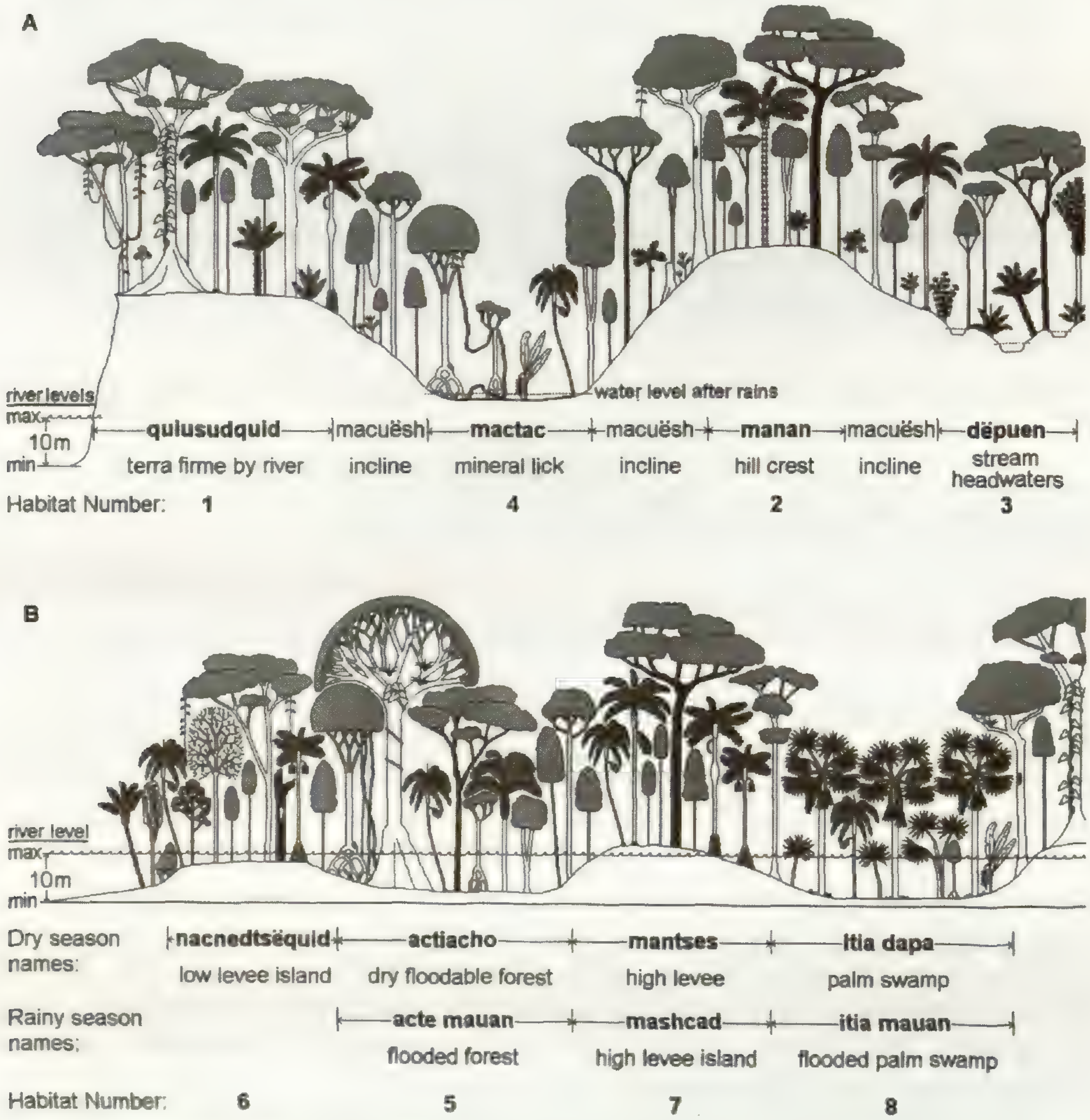

FIGURE 3.-- Profiles of geomorphologically-defined habitat types: A) upland forest habitat types; B) floodplain forest habitat types, showing the annual range of water levels and dry season and rainy season names for the same habitat type.

A large proportion of the observations of some species of mammals were in certain habitat types (Table 4). Many of these values for sightings or signs were more than one order of magnitude higher than would have been expected based on the estimated amount of time Matses spend hunting in each habitat. This suggests that despite the large sampling bias, the listed species might show an actual preference for those habitats.

The Matses system of habitat classification is different from other published rainforest classification systems (e.g., Pires 1973; Prance 1978, 1979; Braga 1979; Malleux 1982; Pires & Prance 1985; Encarnación 1985, 1993) in that it recognizes an exceptionally large number of named habitats for a relatively small area and in that it uses two overlapping subsystems (geomomorphological and vegetative), rather than being strictly hierarchical. This study showed that these Matses-recognized habitat types can be recognized based on standard floristic and structural features (Figure 5). Moreover, these habitat types can be correctly predicted by CART analysis (Figure 7) and they can be identified with dichotomous keys (Appendices A & B).

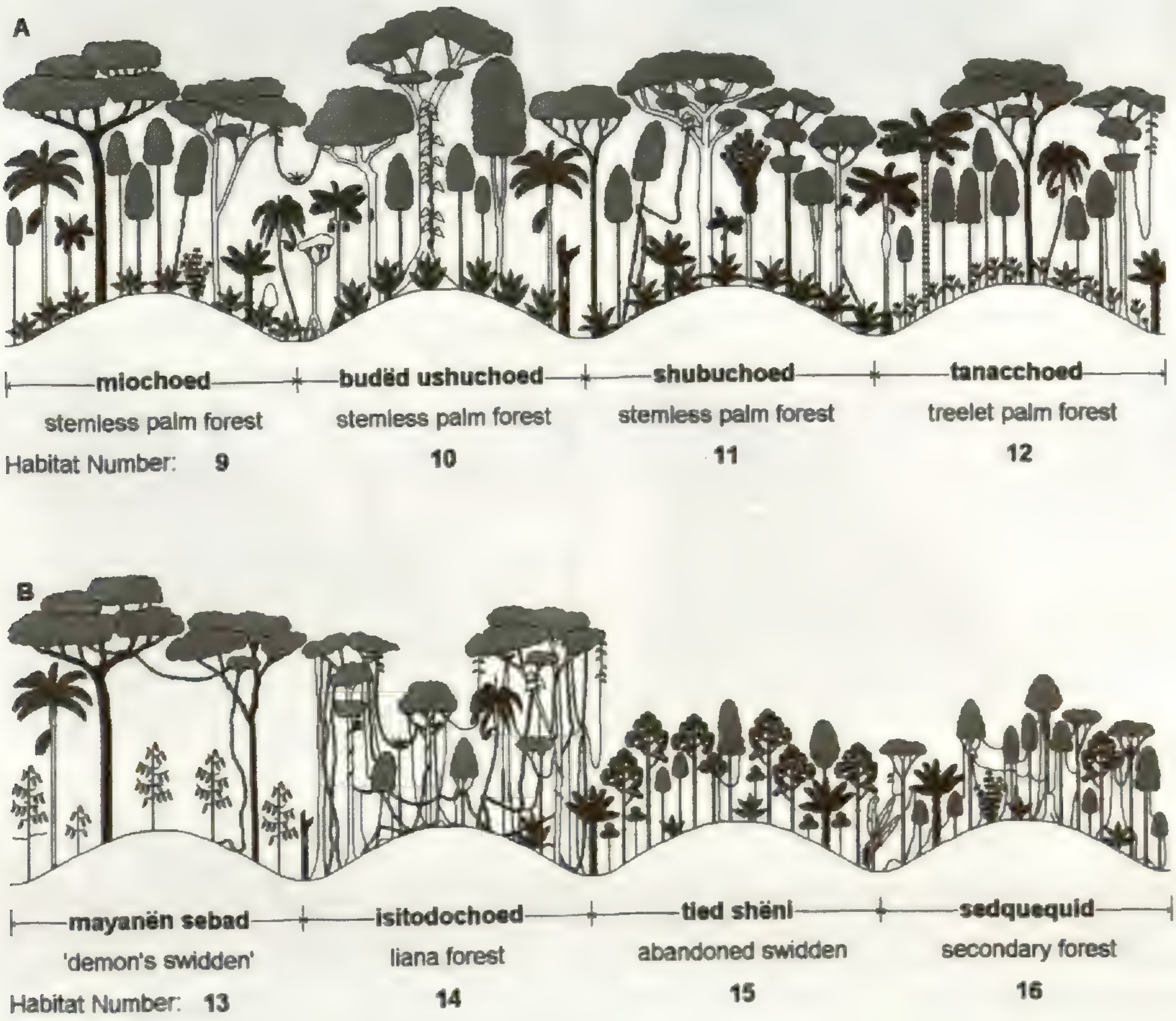

FIGURE 4.– Profiles of vegetatively-defined upland habitat types: A) habitat types dominated by understory palms; B) habitat types with other characteristic vegetation structures.

Geomorphologically-defined habitats are identified by abiotic features including distance from a river, relative elevation, drainage quality, and water regime. Habitat types such as ***manan***[2] 'hill crest', ***actiacho*** 'seasonally flooded forest', and ***quiusudquid*** 'terra firme next to a river' are identified using geomorphological features (Figure 3). All the rainforest in the Gálvez River drainage basin is included in the geomorphologic classification system (Figure 2). Floristic composition and vegetation structure can be affected by water regime, drainage, topography, and

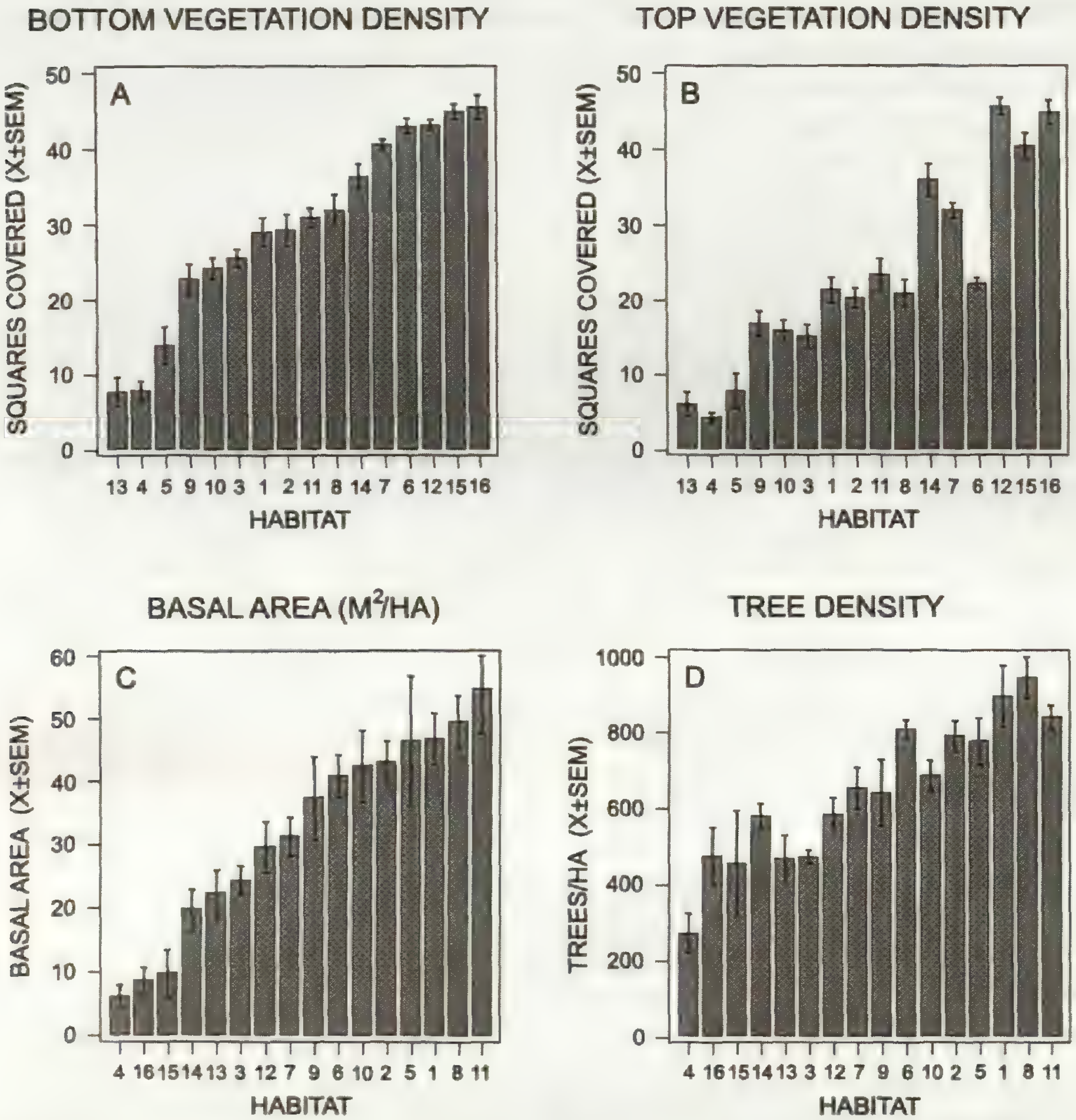

FIGURE 5.– Mean (±SEM) vegetation density, basal area (m^2/ha) and trees (>10 cm DBH) per ha for 16 Matses-recognized habitat types. Habitats in panel A are listed in order of increasing mean number of squares covered; habitats in panel B are listed in the same order as in panel A to illustrate differences in horizontal vegetation density between the lower level (0-0.5 m) and the higher level (0.5-1 m). Habitats in panel C are presented in order of increasing mean basal area; in panel D habitats are in the same order as in panel C to illustrate differences between basal areas and trees per ha in the same habitat types.

TABLE 2.– Frequency of occurrence of 20 palm species in Matses-recognized habitat types. Values represent the number of 0.02-ha plots, out of eight sampled per habitat type, in which a species was recorded (values appear in **bold** type when the palm species is part of the name of the habitat type). Numbers preceding palm species (1-20) correspond to numbered drawings in Figure 6. Habitat type numbers (1-16) correspond to numbered habitats in Table 1 and Figures 2-4).

PALM SPECIES	HABITAT TYPES															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 *Astrocaryum chambira*	1	3							1		3	4		1	3	2
2 *Astrocaryum jauari*					2											
3 *Astrocaryum murumuru*	6	5	7		2				5	3	5	5		4	4	1
4 *Attalea butyracea*					3	1	1								2	
5 *Attalea insignis*			2						2							3
6 *Attalea microcarpa*	5									**8**		1		1		1
7 *Attalea racemosa*			5						**8**		5	3	1		2	3
8 *Attalea tessmanii*			1						1		5					1
9 *Euterpe precatoria*			1	3	6	8	8	8	3		2	3		3		
10 *Hyospathe elegans*		3	1						1		2	1				
11 *Iriartea deltoidea*	4		2	1			4	3			3		1			
12 *Iriartella stenocarpa*		2								1						
13 *Lepidocaryum tenue*		1										**8**				
14 *Mauritia flexuosa*								**8**								
15 *Oenocarpus bataua*	7	6	6				3		5	4	3	4	1			2
16 *Oenocarpus mapora*					1		2	2	1							
17 *Pholidostachys synanthera*		3									2					
18 *Phytelephas macrocarpa*			3						3		**8**				2	
19 *Socratea exorrhiza*						2	7	6		3		2				
20 *Wettenia augusta*		1	1								1					

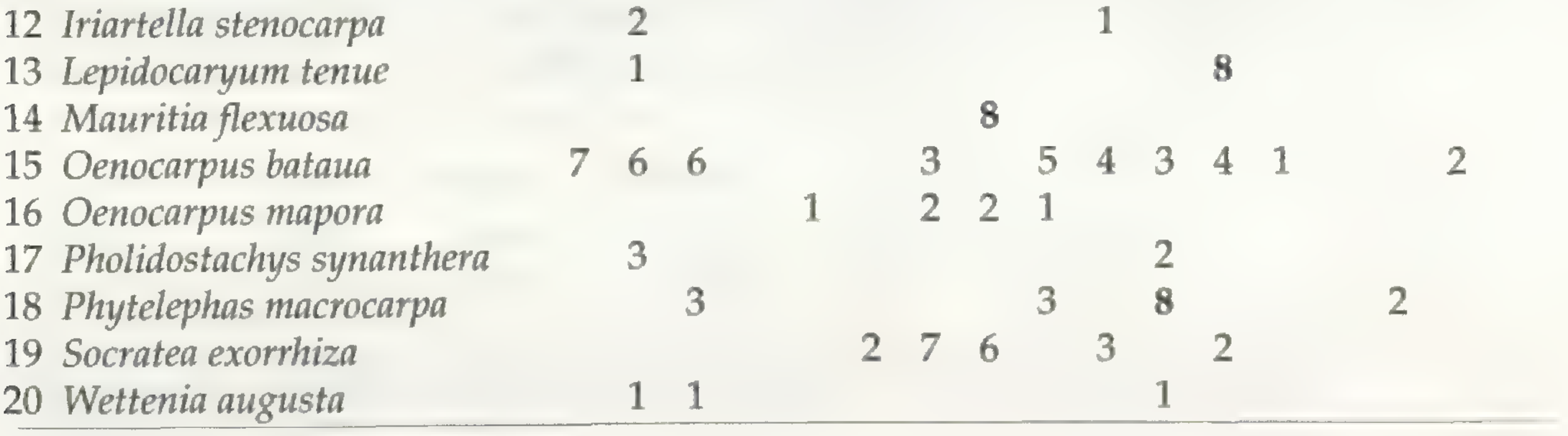

FIGURE 6.– Drawings (to scale) of palms species identified in Matses-recognized habitats. Numbers correspond to numbered palm species in Table 2.

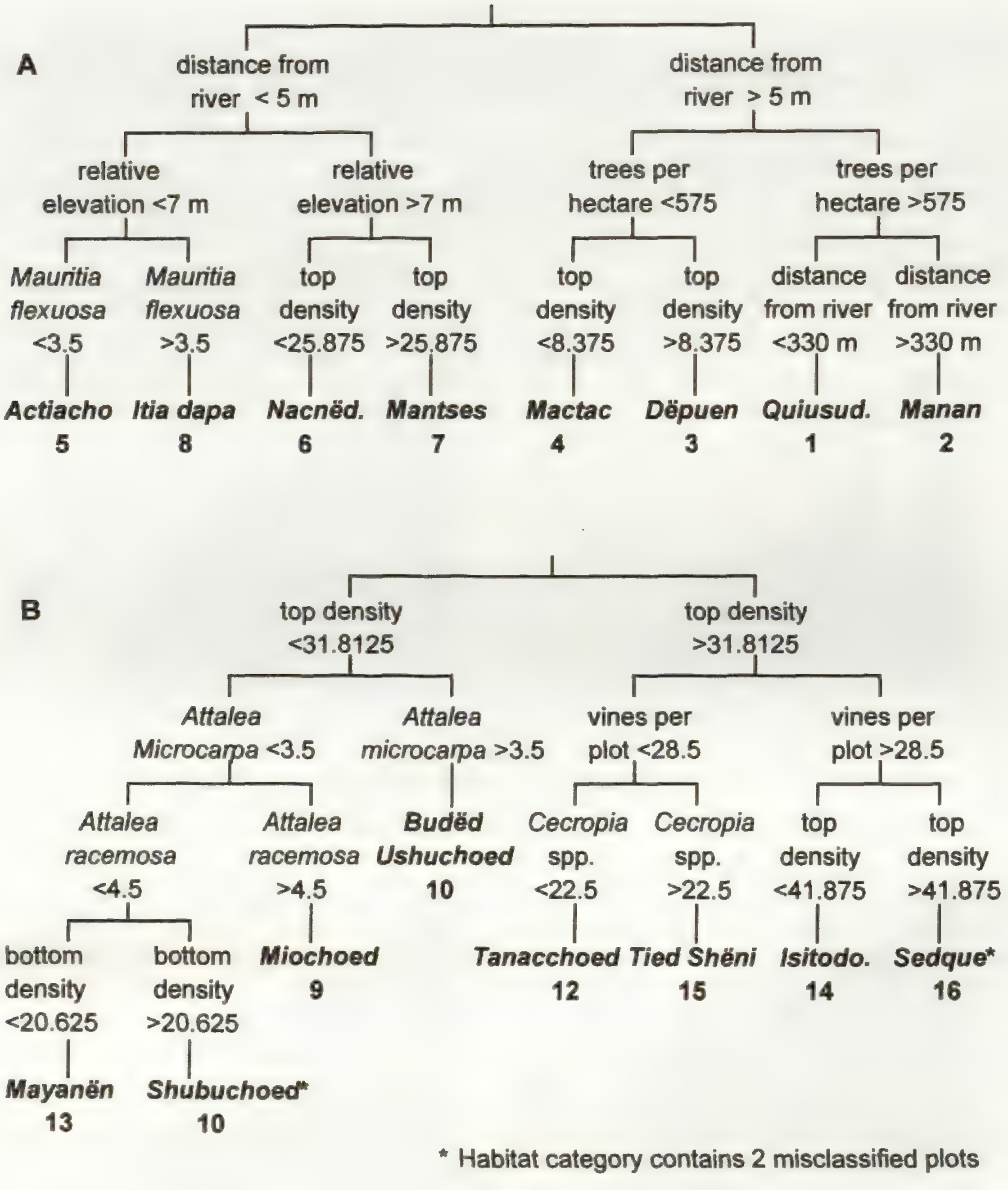

FIGURE 7.– A) Classification and regression tree for eight geomorphologically-defined habitat types. Misclassification error rate was 0% for the 64 plots. Measured habitat characteristics used to construct the tree included distance of the plot from the Gálvez river, relative elevation above lowest land within 50 m, number of trees per ha, number of *Mauritia flexuosa* palms in the plot, and horizontal vegetation density 0.5 to 1 m above the ground. B) Classification and regression tree for eight vegetatively-defined habitat types. Misclassification error rate was 6.25 percent (4 of 64 plots). Measured habitat characteristics used to construct the tree included horizontal vegetation density 0.5 to 1 m above the ground, number of *Attalea microcarapa* palms in the plot, number of vines, number of *Attalea racemosa* palms, number of *Cecropia* spp. trees, and horizontal vegetation density below 0.5 m.

distance from the river, and other physical factors (Duivenvoorden 1996), so geomorphologically-defined habitats generally contain a circumscribed range of species and predictable structures.

Vegetatively-defined habitats are identified primarily by the presence of an obvious dominance by a plant species (e.g., certain palms) or plant life form (e.g., lianas) throughout the habitat. ***Miochoed*** 'forest characterized by *Attalea racemosa* (an understory species of stemless palm)' and ***isotodochoed*** 'forest characterized by lianas' are examples of habitat types defined this way (Figure 4). Named vegetatively-defined habitats cover only 10-15 percent of the rainforest (Figure 2). The remainder of the area, called ***nimëduc*** is not differentiated in the Matses classification.

Because the entire rainforest is divided into both geomorphologically defined habitats and vegetatively-defined habitats, the two must overlap (Figure 2). Some vegetatively-defined habitat types can occur in several different geomorphologically-defined habitat types, so there is not a one-to-one correspondence between the two subsystems. By combining the geomorphological and the vegetative habitat classifications, the Matses can refer to any locality with more detail and efficiency (Table 5). This seems to be a very practical solution considering that it would re-

TABLE 3.– Captures of mammal species during 1000 trapnights in each of 10 Matses-recognized rainforest habitat types. (Common names in Appendix C.)

MAMMAL SPECIES	TRAPPED HABITATS										OCCURRENCE	TOTAL CAPTURES
	3	5	7	8	9	11	12	13	14	15		
Didelphis marsupialis				1		2				1	3	4
Marmosa murina					1					1	2	2
Marmosops noctivagus					2		3	1	4	1	5	11
Metachirus nudicaudatus					1	1			1	2	4	5
Micoureus spp.				1	3	1	1		1	1	6	8
Philander mcilhennyi	1				1	2				1	4	5
Oecomys bicolor			1			1					2	2
Oecomys cf. *trinitatis*		3									1	3
Oryzomys perenensis				1							1	1
Oryzomys macconnelli cf.								1			1	1
Scolomys ucayalensis						1					1	1
Mesomys ferrugineus						1					1	1
Proechimys cuvieri	1									1	2	2
Proechimys sp. 1			2								1	2
Proechimys sp. 2			2	1	1					2	4	6
Proechimys sp. 3			1		1			1			3	3
Proechimys sp. 4	3				6	4	2	3	2	1	7	21
Proechimys sp. 5							1	2			2	3
Proechimys sp. indet.*	4	2	1	1	2	2	6	4	7	10	10	39
Total Species (20)	3	2	4	4	8	8	4	5	4	9		
Total Captures	9	5	7	5	18	15	13	12	15	21		120

* Unidentifiable because captured animals were juveniles or skulls were crushed by kill bar.

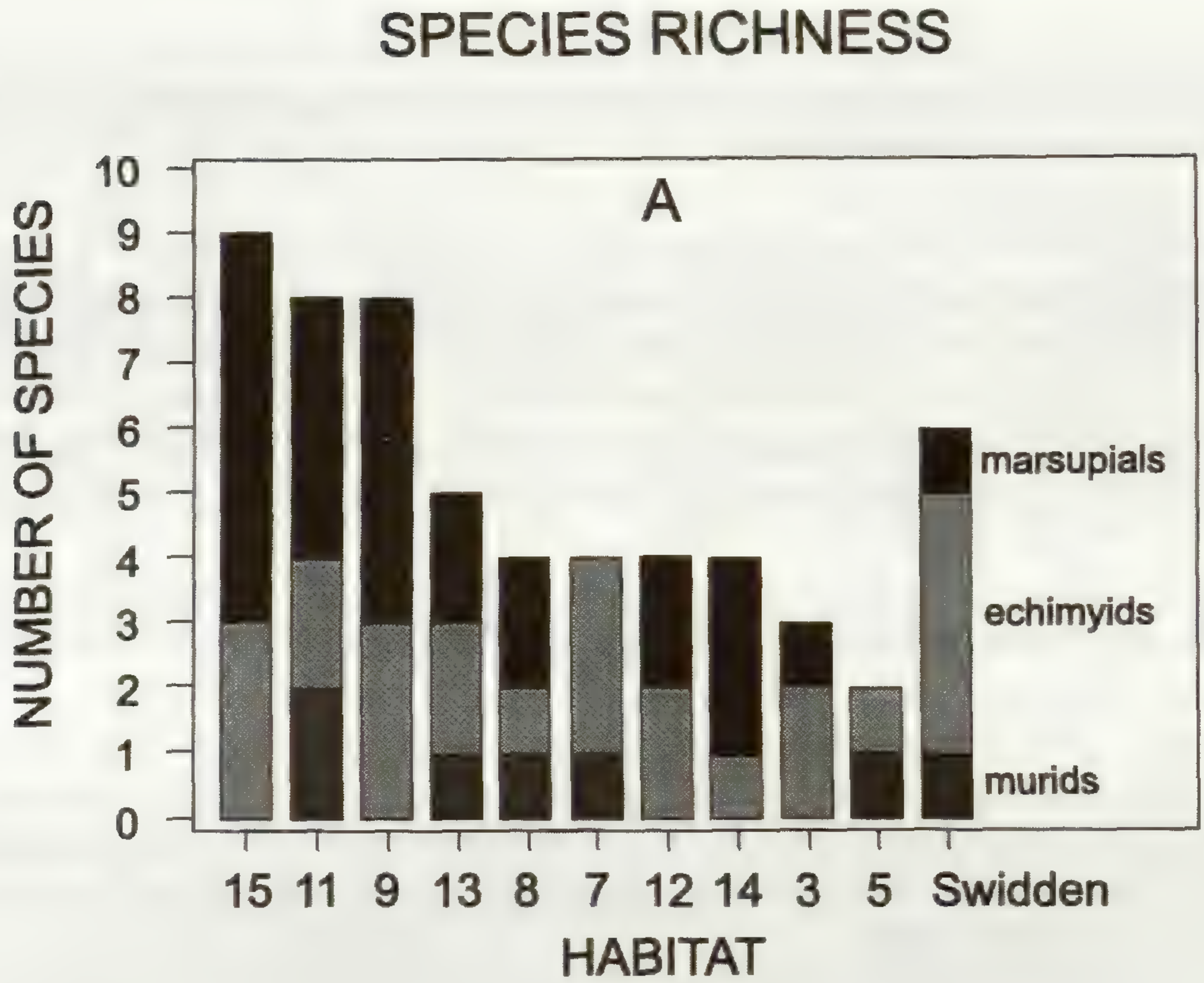

FIGURE 8.– Species richness (A) and abundance (B) of marsupials, echimyid rodents, and murid rodents based on data from 1000 trapnights in 10 Matses-recognized habitat types (and in a Matses manioc swidden). Data are presented for three groups (taxa): marsupials (family Didelphidae); echimyid rodents (family Echimyidae); and murid rodents (family Muridae).

quire much repetition to include such detail in a strictly hierarchical system. It should be noted that lexemes for the two classes of habitat designations are not combined by forming compounds or lexicalized phrases, but rather may simply be mentioned in the same conversation to designate a more specific habitat type or to describe a particular locality.

The Matses system is also useful because habitats belonging to a particular habitat type have several attributes in common (i.e., the categories are polythetic or logically natural). Because traditional societies rely heavily upon the environment for subsistence, a habitat classification system that is useful for multiple subsistence activities (hunting, trapping, and gathering of food, medicines and construction material) would be useful and therefore more likely to be maintained in a culture.

TABLE 4.– Mammal species that were frequently detected in Matses-recognized habitat types. The percentages of time spent in habitat types while hunting were calculated based on paced trail lengths. Sightings include animals killed or observed while hunting. Signs include fresh tracks and new dens. Proportions of sightings/signs were calculated as the number of times a species was recorded in a habitat type, divided by the total number of times that species was recorded while hunting. Calculations are separate for geomorphologically-defined (1-8) and vegetatively-defined (9-16) habitat types.

HABITAT TYPE	TIME IN HABITAT	MAMMAL SPECIES	SIGHTINGS IN HABITAT	SIGNS IN HABITAT
1 ***quiusudquid***	1-2%	*Saimiri sciureus*	19%(5/26)	
2 ***manan***	30-40%	*Priodontes maximus*	0% (0/1)	79%(31/39)
3 ***dëpuen***	3-5%	*Dasypus kappleri*	70%(7/10)	65%(30/46)
4 ***mactac***	<1%	*Ateles chamek*	43%(9/21)	
		Tapirus terrestris	33%(2/6)	49%(23/47)
		Tayassu pecari	40%(6/15)	52%(22/42)
5 ***actiacho***	5-10%	*Allouata seniculus*	89%(16/18)	
		Saimiri sciureus	62%(16/26)	
		Isothrix bistriata	81%(18/22)	
6 ***nacnëdtsequid***	<1%	*Dasypus novemcinctus*	50%(2/4)	53%(9/17)
7 ***mantses***	<1%	*Dasypus novemcinctus*	25%(1/4)	29%(5/17)
		Agouti paca	20%(1/5)	23%(7/30)
8 ***itiadapa***	2-3%	*Cacajao calvus*	52%(11/2)	
		Tapirus terrestris	33%(2/6)	26%(12/47)
9 ***miochoed***	5-10%	*Dasypus kappleri*	40%(4/10)	39%(18/46)
10 ***budëdushuchoed***	1-2%			
11 ***shubuchoed***	3-5%	*Mazama americana*	20%(1/5)	27%(3/11)
12 ***tanacchoed***	2-3%	*Pecari tajacu*	29%(2/7)	25%(15/59)
		Myrmecophaga tridactyla	33%(1/3)	28%(5/18)
13 ***mayanën sebad***	2-3%			
14 ***isitodochoed***	1-2%	*Choloepus hoffmanni*	36%(4/11)	
		Cabassous unicinctus	0% (0/1)	48%(14/29)
15 ***tied shëni***	5-10%	*Agouti paca*	40%(2/5)	37%(11/30)
		Dasyprocta fuliginosa	60%(9/15)	44%(4/9)
16 ***sedquequid***	2-3%	*Saguinus fuscicollis*	38%(10/26)	
		Saguinus mystax	26%(8/31)	

TABLE 5.--Relationship between named rainforest habitat types, showing which vegetatively-characterized habitat types are found on which geomorphologically-defined habitat types. By using two names, the Matses can describe as many as 104 types of primary rainforest and 74 types of secondary rainforest.

VEGETATIVELY-DEFINED HABITAT TYPES.		GEOMORPHOLOGICALLY-DEFINED HABITAT TYPES. *Mananucquio*									*Acte cuëman*						
		1	2				3	4			5	6	7			8	
		q	*m*	*m*	*t*	*a*	*a*	*d*	*m*	*i*	*a*	*a*	*n*	*m*	*c*	*a*	*i*
		u	*a*	*a*	*s*	*c*	*c*	*ë*	*a*	*t*	*n*	*c*	*a*	*a*	*h*	*c*	*t*
		i	*n*	*c*	*i*	*t*	*t*	*p*	*c*	*i*	*s*	*t*	*c*	*n*	*i*	*t*	*i*
		u	*a*	*u*	*m*	*e*	*e*	*u*	*t*	*a*	*h*	*i*	*n*	*t*	*a*	*e*	*a*
		s	*n*	*ë*	*p*	*d*	*c*	*e*	*a*		*a*	*a*	*ë*	*s*	*n*		
		u		*s*	*i*	*a*	*u*	*n*	*c*		*n*	*c*	*d*	*e*	*c*	*m*	*d*
		d		*h*	*r*	*d*	*i*				*t*	*h*	*t*	*s*	*u*	*a*	*a*
		q			*u*	*a*	*d*				*u*	*o*	*s*		*ë*	*c*	*p*
		u			*c*		*i*				*c*		*ë*		*m*	*t*	*a*
		i				*c*							*q*		*a*	*a*	
		d				*u*	*c*						*u*		*n*	*c*	
						ë	*u*						*i*				
						m	*ë*						*d*				
						a	*m*										
						n	*a*										
							n										
Primary Forest																	
	nimëduc$_2$	X	X	X	X	X	X	X	X		X	X	X	X	X	X	
	isanchoed	X	X														
	nistechoed				X	X	X										
	shuinte mapichoed		X														
	budëdchoed				X	X											
9	*miochoed*	X	X	X	X	X	X	X									
10	*budëd ushuchoed*	X	X	X	X		X	X									
11	*shubuchoed*	X	X	X	X	X	X	X				X	X	X	X		
12	*tanacchoed*		X	X	X	X	X	X									
	dapaischoed	X	X	X	X	X	X	X									
	cobisanchoed				X						X						
	tiantechoed				X	X	X										
	sëntechoed	X	X	X	X	X	X	X									
	pëncadchoed		X	X	X	X	X	X									
	mani padachoed		X	X	X	X	X	X									
13	*maynën sebad*	X	X	X	X		X	X									
14	*isitodochoed*		X	X													
	cuëte mampis		X														
	itia								X								
	antinchoed											X			X		
	sinadchoed											X	X		X		
	shiuishchoed											X			X	X	
	canashëtachoed											X			X		
	itia dapa																X
Secondary Forest																	
15	*tied shëni*	X	X	X													
	mayun tied	X	X	X		X	X										
	cuesbudaid	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	isitodochoed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	bucuchoed	X	X	X	X	X	X	X				X	X	X	X		
16	*sedquequid*	X	X	X	X	X	X	X	X			X	X	X	X		
	cuëteuidquio tabad.	X	X	X	X	X	X	X				X	X	X	X		

For example, the Matses habitat ***shubuchoed*** *'Phytelephas microcarpa* stemless palm forest' is notable to the Matses for containing palms for thatch (*P. microcarpa*), being located on good soil that is ideal for making swiddens, and having high densities of trees with edible fruits, which can be harvested seasonally and attract game.

Although the Matses habitat classification system is not entirely hierarchical, each of the two subsystems is. Geomorphologically-defined habitat types are classified into two major categories: ***mananucquio***, upland rainforest that is not affected by seasonal flooding of a river (Table 1; Figure 3A), and ***acte cuëman***, floodplain forest along a river that is subjected to seasonal flooding (Table 1; Figure 3B). Vegetatively-defined habitats are arranged in a very shallow hierarchy and are placed into two general categories: ***nimëduc*** 'primary rainforest' and an unnamed category for secondary rainforest habitats (Table 1; Figure 4). Thus, ***nimëduc*** has both a general and a specific definition (i.e., it is polysemous with referents at two taxonomic levels). In the general sense it means all primary rainforest (***nimëduc***$_1$), and in the specific sense it refers to all primary rainforest excluding the other named vegetatively-defined habitats (***nimëduc***$_2$). The Matses do not have a named category for "secondary forest", but interview responses clearly show that they place successional forest habitat types into a category that is separate from the named category for primary rainforest, ***nimëduc***$_1$ (i.e., "secondary forest" is a covert category [Berlin et al. 1968]).

Primary rainforest is characterized by high diversity and infrequent clumping of one plant species (Gentry 1992), so the Matses habitat types that are characterized by a dominant species of plant are the exception. The occurrence of vegetatively defined habitat types cannot be predicted by geomorphological factors alone, but their distribution is probably related to some combination of edaphic, historical, and biological factors which favor dominance of some species. For example, higher densities of *Lepidocaryum tenue,* (the colonial treelet palm that dominates ***tanacchoed***) were found in yellow ferralitic soil in higher densities than in poorly-drained gleyic soil (Kahn & Mejia 1987). The high densities of *Duroia hirsuta* and the dearth of understory vegetation in Devil's gardens (called by Matses ***mayanën sebad*** 'demon's swidden'; Figure 4B) may be the result of a potentially allelopathic iridoid lactone (plumericin) produced by *D. hirsuta* (Page et al. 1994). The scarcity of pioneer species (e.g., *Cecropia* spp.) in ***sedquequid*** 'natural secondary forest' (Figure 4B) compared to ***tied shëni*** 'secondary forest from abandoned swiddens' (Figure 4B) is likely due to advanced regeneration in natural treefall gaps from preexisting small trees in arrested growth stages that are not killed by treefalls (Uhl et al. 1988).

Miochoed *'Attalea racemosa* stemless palm forest' and ***budëd ushuchoed*** *'Attalea microcarpa* stemless palm forest' (Figure 4A) have not been described as rainforest habitat types in the literature (although Henderson [1994] noted that *Attalea racemosa* sometimes forms dense colonies). Perhaps *P. macrocarpa* and *L. tenue* palm forest habitats are more likely to find their way into the literature because they are very important sources of thatch in the Peruvian Amazon, while *Attalea* spp. are not. ***Miochoed*** and ***budëd ushuchoed*** (and ***shubuchoed***, *'Phytelephas macrocarpa* stemless palm forest'; Figure 4A), however, are important to the Matses because great long-nosed armadillos, *Dasypus kappleri,* an important game species, are found frequently in these habitats. ***Shubuchoed*** and ***miochoed*** had relatively high small

mammal abundance and species richness, especially for marsupials, compared to other trapped habitats. This may be due to large numbers of macroinvertebrates that thrive in the leaf litter collected in the bases of stemless palms (de Vasconcelos 1990) which may provide food for marsupials. ***Mayanën sebad*** 'demon's swidden' is not an economically useful habitat for Matses, but these anomalous open zones in otherwise dense tropical forest are too obvious to go unrecognized.

Kahn (1987) found that in eastern Amazonia, differences in palm species composition and abundance exist among hill plateaus, hill crests, hill slopes (inclines) and depressions between hills; these differences were attributed to differences in declivity (angle of slope) among the sites, which affected the drainage and canopy structure, thereby creating different abiotic and biotic conditions for palms. Similarly, relatively small variation in elevation (39 m) can affect rainforest tree species composition (Lieberman et al. 1985); hills in the Nuevo San Juan area can rise up to 60 m above adjacent gullies. These studies lend credibility to the Matses perception that hill crests and hill inclines differ vegetatively.

Knowledge of rainforest habitats is important not only for describing floristic diversity, but also for understanding the ecology of animals in those areas. Capybara (*Hydrochaeris hydrochaeris*) in Amazonian Peru used beaches, *Cecropia* forests, and low levees more often than swamps, low flooded forests, and high levees (Soini & Soini 1992). Woolly monkeys (*Lagothrix lagotricha*) used *colinas* (inland hilly forest) and *igapó* (seasonally flooded blackwater forest) more often than expected in Amazonian Colombia (Defler 1996). Squirrel monkeys (*Saimiri sciureus*) in Surinam showed a preference for liane forests and were found most often in that formation (Mittermeier & van Roosmalen 1981). Results of habitat-mammal associations recorded while hunting with Matses reflect too much sampling bias to reliably determine habitat preferences by game mammals, but the high proportion of time that game species were found in certain habitats illustrates the importance to Matses hunters of recognizing many habitat types in order to hunt more efficiently.

Very poor drainage and perhaps toxic levels of some minerals in the soil seem to inhibit growth of trees so that a conspicuously low basal area and tree density exist in ***mactac*** 'muddy mineral lick' Figure 3A). *Mactac* habitats are important to the Matses for hunting and they intentionally make their paths through ***mactac*** because of the high likelihood of finding game there. Tapirs (*Tapirus terrestris*), white-lipped peccaries (*Tayassu pecari*), and spider monkeys (*Ateles chamek*) were found very often in this habitat, as well as howler monkeys (*Alouatta seniculus*), collared peccaries (*Pecari tajacu*), and brocket deer (*Mazama americana, M. gouazoupira*).

The vegetation in ***dëpuen*** 'stream headwaters' is neither conspicuously different from that in the surrounding habitats nor does this habitat type contain a high concentration of economically important plant species, but it is important for hunting armadillos (*Dasypus kappleri*). *D. kappleri* make burrows in the eroded sides of **dëpuen** gullies and the Matses have become quite skilled at detecting occupied burrows and flooding out the armadillos. The preferred location for searching for *D. kappleri* is in ***dëpuen*** that overlaps ***miochoed, budëd ushuchoed,*** or ***shubuchoed.*** According to the Matses, armadillo paths are very common in these vegetatively-defined habitats because they contain good soil with large numbers of soil invertebrates. In fact, the preferred location for Matses to make swiddens is on ***shubuchoed, miochoed,*** or ***budëd ushuchoed,*** but not where these overlap ***dëpuen,***

but rather where they occur on ***manan*** 'hill crests' and ***macuësh*** 'hill incline' or on ***quiusudquid*** 'terra firme next to a river'. Thus, it can be seen that Matses subsistence activities and knowledge of natural history knowledge are sensitive to habitat types that are not lexicalized, but that they can, nevertheless, refer to with precision using a combination of names from the two habitat classification subsystems.

The Matses utilize their knowledge of habitat types to understand seasonal movements of animals. Folk natural history information from the Matses describes the movements of frugivores across several habitat types in response to habitat-specific seasonal availability of fruit and secondary foods (Harder & Fleck 1997). Many animals move between rainforest habitats during the course of the year (e.g., ungulates: Bodmer 1990), and utilize seasonally available resources in different habitat types within the upland and floodplain rainforests (e.g., primates: Peres 1994; Stevenson et al. 1994; Defler 1996).

Species richness of trapable small mammals was lower in ***actiacho*** 'seasonally flooded forest' than in any of the upland habitats, a trend similar to that found in upland rainforest and blackwater seasonally flooded rainforest habitats near the Ucayali River in Loreto, Peru (Fleck & Harder 1995). An important difference between two types of successional forest recognized by the Matses is that ***tied shëni*** had the highest abundance of small mammals of the 10 sampled rainforest habitats, while auxiliary trapping in ***sedquequid*** (350 trapnights) produced zero captures. Second to active swiddens, ***tied shëni*** is the Matses' favorite habitat type for trapping *Proechimys* rats.

Use of local habitat classifications of indigenous people is not a substitute for extensive regional surveys as in Terborgh and Andresen (1998) or for broader descriptions based on gradients in soil types and hydrology. Nevertheless, there are several applications of indigenous classification systems for diversity inventories and management planning. For example, a researcher could consult locals about the habitat types they recognize and ask to be led to the different habitats, thus efficiently finding some habitat types that might contain fauna or flora that is rare elsewhere, and would otherwise be detected only by chance. One innovative application of folk classification systems is Shepard et al.'s (in press) utilization of the rainforest habitat classification system of the Matsigenka Indians of Amazonian Peru to interpret LANDSAT images. Another use of indigenous habitat classification and resource knowledge is in designing, implementing and managing communal reserves, national parks and other natural protected areas with indigenous populations. A case in point is the use of Matsigenka ecological knowledge described by Shepard (in press) to form a baseline for implementing a recently-approved Conservation International project in the Vilcabamba Cordillera of Peru that engages the local indigenous groups as primary stewards of two communal reserves and as stakeholders in a proposed national park.

In order to develop effective conservation policy in Amazonian countries, it is essential to have an understanding of habitat heterogeneity in Amazonia, but unfortunately at present there is not a habitat classification system for Amazonia available to scientists and policy makers that considers all minor habitat types such as those described in this paper. One way to develop a comprehensive habitat classification system for Amazonia would be to compile descriptions of habitat types recognized by locals and biologists throughout the Amazon basin, deter-

mining which described habitats are similar enough to be considered a single habitat type, and determining whether habitats are geomorphologically or vegetatively-defined. The fact that Shepard et al. (in press) found a comparable classification system for the Matsigenka (more than 40 named habitat types in independent geomorphological and vegetation classifications) suggests that compiling a classification of Amazonian habitats in this way would be practicable. The problem with this approach is time. Indigenous knowledge of habitat classification is passed in an oral natural history that depends upon active hunting in traditional ways. These ways are being threatened by the onslaught of western culture. As young men move to cities or adopt western methods of hunting with shot guns and flashlights, fewer will learn or become skilled in traditional ways that depend heavily upon the indigenous habitat classification. Thus, it is important to study native habitat classifications before they are lost to cultural change along with their potential value to ecology and conservation.

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NOTES

[1] The first author's current address, to where correspondence should be sent, is:
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[2] The orthography used here is the practical orthography developed by SIL personnel for Bible translation and pedagogical materials, which has become the official writing system for the Matses (Kneeland 1979). The alphabet is phonemically-based and modeled after Spanish orthography. To produce a pronunciation that approximates Matses, words written in this orthography may be pronounced as if reading Spanish, with the following exceptions: ***ë*** is a high central unrounded vowel [ ]; ***c*** (spelled ***qu*** preceding ***e***, ***ë*** and ***i***) is pronounced as a glottal stop word-finally and preceding consonants, and as [k] elsewhere; ***d*** is pronounced as a flap [ ] between vowels, and as a [d] elsewhere; and ***ts*** should be read as an unvoiced alveolar affricate. Word-level stress is on even-numbered syllables (counting from left to right) unless otherwise marked.

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APPENDIX A.– Key for identification of Matses-named geomorphologically-defined rainforest habitat types found within 2 km of Nuevo San Juan

1 More than 3 m above normal peak river level, near or far from a river, never flooded by seasonal rise of a river ..... Go to 2
1' Less than 3 m above normal peak river level, always near a river, subject to seasonal flooding of a river ..... Go to 9

2 Elevation rising 10-60 m above surrounding land ..... Go to 3
2' In a valley between hills ..... Go to 5

3 Adjacent to river, (up to 100 m from river)***quiusudquid***, terra firme adjacent to a river
3' At least 100 m from river ..... Go to 4

4 Top of hill with incline <15° ..... ***manan***, hill crest
4' Side of hill with incline >15°, 10 m above lowest point of valley ..... ***macuësh***, hill incline

5 Along a stream ..... Go to 6
5' Not along a stream ..... Go to 8

6 Among several headwater gullies, gullies contain running water only during and immediately after rains ..... ***dëpuen***, stream headwaters
6' Along a stream >1 m wide, stream contains water all year ..... Go to 7

7 Along a stream >3 m wide, stream floods during heavy rains ***acte dada cuëman***, gallery forest along large stream
7' Along a stream >1 m and <3 m wide, stream swells during rains, but does not overflow banks during heavy rains .. ***acte cuidi cuëman***, gallery forest along small stream

8 Very poor drainage, ground always waterlogged or muddy ..... ***mactac***, mineral lick
8' Area between gallery forest and hill inclines, fair drainage, ground damp, but never waterlogged ..... ***tsimpiruc***, valley

9 "Island" elevated 7-13 m above surrounding land, does not flood during most of rainy season ..... Go to 10
9' Relatively flat land, floods during most of rainy season ..... Go to 11

10 0-3 m below normal peak river level, flooded yearly, but only for a few weeks during highest water ..... ***nacnëdtsequid***, low levee island
10' 0-3 m above normal peak river level, only floods on years of exceptionably high river levels ..... ***mantses***, high levee island

11 Adjacent to a river or higher than land separating it from a river, drains well during dry season ..... ***actiacho***, seasonally flooded forest
11' Never adjacent to a river, lower than land separating it from the river, ground remains waterlogged during rainy season, dominated by *Mauritia flexuosa* palms ..... ***itia dapa***, palm swamp

APPENDIX B.– Key for identification of Matses-named vegetatively-defined rainforest habitat types found within 2 km of Nuevo San Juan

1 Primary rainforest vegetation, trees at least 40 m high, some trees with thick (DBH > 0.6 m) trunks ..... Go to 2
1' Secondary rainforest vegetation, trees not reaching 40 m, no trees with thick trunks Go to 8

2 Forest understory dominated by palms ..... Go to 3
2' Forest understory not dominated by palms ..... Go to 6

3 Forest understory dominated by treelet palms (*Lepidocaryum tenue*) ..... ***tanacchoed***, *Lepidocaryum tenue* treelet palm forest
3' Forest understory dominated by stemless palms (*Attalea* or *Phytelephas)* ..... Go to 4

4 Forest understory dominated by *Phytelephas* sp. palms ..... ***shubuchoed***, *Phytelephas macrocarpa* dwarf palm forest
4' Forest understory dominated by *Attalea* sp. palms ..... Go to 5

5 Forest understory dominated by *Attalea racemosa* palms .... ***miochoed***, *Attalea racemosa* dwarf palm forest
5' Forest understory dominated by *Attalea microcarpa* palms ... ***budëd ushuchoed***, *Attalea microcarpa* dwarf palm forest

6 Forest understory and midstory with low vegetation density and dominated by *Duroia hirsuta* (small dicot trees) ..... ***mayanën sebad***, *Duroia hirsuta* 'demon's swidden'
6' Forest not dominated by *Duroia hirsuta* ..... Go to 7

7 Forest dominated by numerous large and small lianas, high vegetation density ***isitodochoed***, liana forest
7' Forest not dominated by any salient form of vegetation ... ***nimëduc$_2$***, undifferentiated primary forest

8 Forest dominated by *Cecropia* spp. *Marila* spp. and other pioneer tree species, relatively few lianas, few primary forest species; from an abandoned Matses swidden ***tied shëni***, abandoned swidden
8' Forest containing a wide variety of primary forest species that have sprouted vegetatively from stumps and roots of fallen trees, mixed with pioneer tree species, contains many small lianas and creeping vines; not from an abandoned swidden . ***sedquequid***, natural secondary forest

Note: The keys in Appendices A and B can be used to describe any locality within 2 km of Nuevo San Juan, Peru using two habitat names, one geomorphologically-defined habitat name and one vegetatively-defined habitat name.

APPENDIX C.– List of 84 non-flying mammal species captured, observed (*), or reported by Matses (**) in the Nuevo San Juan area in 1995-1996.

LATIN NAME[a]	ENGLISH NAME[b]	MATSES NAME[c]
DIDELPHIMORPHIA		
Caluromys lanatus	western woolly opossum	***abuc checa***
Didelphis marsupialis	common opossum	***mapiocos***
Gracilinanus kalinowskii[1]	Kalinowski's gracile mouse opossum	***checampi***
Marmosa murina	murine mouse opossum	***checampi***
Marmosops noctivagus	White-bellied slender mouse opossum	***checampi***
Marmosops impavidus	Andean slender mouse opossum	***checampi***
Metachirus nudicaudatus	brown 4-eyed opossum	***checa dëuisac***
Micoureus demerarae	Long-furred woolly mouse opossum	***checampi***
Micoureus regina	Short-furred woolly mouse opossum	***checampi***
Monodelphis adusta	Sepia short-tailed opossum	***yama***
Monodelphis emiliae	Emilia's short-tailed opossum	***yama***
Philander mcilhennyi[2]	Anderson's gray four-eyed opossum	***checa dëuisac***
XENARTHRA		
Bradypus variegatus	Brown-throated three-toed sloth	***mëincanchush***
Choloepus cf. *hoffmanni*	Southern two-toed sloth	***shuinte***
*Cabassous unicinctus**	Southern naked-tailed armadillo	***mencudu***
Dasypus kappleri	Great long-nosed armadillo	***tsaues***
Dasypus novemcinctus	nine-banded armadillo	***sedudi***
Priodontes maximus	giant armadillo	***tsauesamë***
Cyclopes didactylus	pygmy ant eater	***tsipud***
Myrmecophaga tridactyla	giant ant eater	***shaë***
Tamandua tetradactyla	collared tamandua	***bëui***
PRIMATES		
Callithrix pygmaea	pygmy marmoset	***madun sipi***
Saguinus fuscicollis	saddleback tamarin	***sipi cabëdi***
Saguinus mystax	Black-chested mustached tamarin	***sipi ësed***
*Callimico goeldii**	Goeldi's monkey	***sipi chëshë***
Alouatta seniculus	red howler monkey	***achu***
Aotus nancymaae	night monkey	***dide***
Ateles chamek	black spider monkey	***chëshëid***
Cacajao calvus	red uakari monkey	***senta***
Callicebus cupreus	titi monkey	***uadë***
Cebus albifrons	white-fronted capuchin monkey	***bëchun ushu***
Cebus apella	brown capuchin monkey	***bëchun chëshë***
Lagothrix lagotricha	common woolly monkey	***poshto***
Pithecia monachus	monk saki monkey	***bëshuicquid***
Saimiri sciureus	common squirrel monkey	***tsanca***
CARNIVORA		
*Atelocynus microtis***	short-eared dog	***mayanën opa***
*Speothos venaticus**	bush dog	***achu camun***
*Herpailurus yaguarondi**	jaguarundi	***bëdi chëshë***
Leopardus pardalis	ocelot	***bëdimpi***
*Leopardus wiedii***	margay	***tëstuc mauequid***
*Panthera onca**	jaguar	***bëdi***
*Puma concolor**	puma	***bëdi piu***
Eira barbara	tayra	***batachoed***
*Galictis vittata***	grison	***bosen ushu***
Lontra longicaudis	southern river otter	***bosen***

*Mustela africana***	Amazon weasel	***opampi***
Pteronura brasiliensis	giant river otter	***onina***
Bassaricyon gabbii	olingo	***shëmëin***
Nasua nasua	South American coati	***tsise***
Potos flavus	kinkajou	***cuichic***
*Procyon cancrivorus***	crab-eating raccoon	***tsise biecquid***
CETACEA		
*Sotalia fluviatilis**	gray dolphin	***chishcan chëshë***
*Inia geoffrensis**	pink river dolphin	***chishcan piu***
PERISSODACTYLA		
Tapirus terrestris	Brazilian tapir	***nëishamë***
ARTIODACTYLA		
Pecari tajacu	collared peccary	***shëcten***
Tayassu pecari	white-lipped peccary	***shëctenamë***
Mazama americana	red brocket deer	***senad piu***
Mazama gouazoupira	gray brocket deer	***senad tanun***
RODENTIA		
Microsciurus flaviventer	Amazon dwarf squirrel	***capa cudu***
Sciurillus pusillus	Neotropical pygmy squirrel	***cacsi***
Sciurus ignitus	Bolivian squirrel	***capampi***
Sciurus igniventris	northern Amazon red squirrel	***capa***
Sciurus spadiceus	southern Amazon red squirrel	***capa***
Nectomys apicalis[3]	water rat	***maca tanun***
Oecomys bicolor	arboreal rice rat	***shubu pecquid***
Oecomys cf. *trinitatis*	arboreal rice rat	***abuc macampi***
Oryzomys cf. *macconnelli*	rice rat	***tacbid umu***
Oryzomys perenensis[3]	common rice rat	***tacbid umu***
Oryzomys yunganus	rice rat	***tacbid umu***
Scolomys ucayalensis	gray spiny mouse	***tacbid umu***
Coendou prehensilis	Brazilian porcupine	***isa***
Dinomys branickii	pacarana	***tambis biecquid***
Hydrochaeris hydrochaeris	capybara	***memupaid***
Dasyprocta fuliginosa	black agouti	***mëcueste***
Myoprocta pratti[4]	green acouchi	***tsatsin***
Agouti paca	paca	***tambis***
Isothrix bistriata	yellow-crowned brush-tailed tree rat	***abuc maca***
Makalata didelphoides[5]	red-nosed tree rat	***abuc maca***
Mesomys ferrugineus[4]	spiny tree rat	***abuc maca***
Proechimys brevicauda	spiny rat	***tambisëmpi***
Proechimys cuvieri	spiny rat	***tambisëmpi***
Proechimys kulinae[6]	spiny rat	***tambisëmpi***
Proechimys simonsi	spiny rat	***tambisëmpi***
Proechimys steerei	spiny rat	***tambisëmpi***

[a] Nomenclature follows Wilson & Reeder (1993) unless otherwise noted.

[b] Most common names from Emmons and Feer (1997).

[c] Only lexicalized terms are listed. For the many mammal species that are lexically overdiffentiated by the Matses (see Fleck *et al.* 1999 for primate overdifferentiation by the Matses), the Matses name given represents the non-terminal lexeme that corresponds most closely to the scientific species. Also, many of the game species have multiple synonymous names, in this list the most common synonyms used at Nuevo San Juan are presented here.

[1] Hershkovitz (1992)
[2] Patton & da Silva (1997)
[3] Patton *et al.* (2000)
[4] Voss *et al.* (in press)
[5] Emmons (1993)
[6] da Silva (1998)

APPENDIX D.– Linguistic analysis of habitat terminology.

Here all the habitat types listed in Table 1 are analyzed linguistically. Habitats are listed and discussed in three sections based on their analyzability. The first and second categories include terms that are not synchronically segmentable, and correspond to Conklin's (1962:123) "unitary simple lexemes" and Berlin et al.'s (1973:217) "(unanalyzable) primary lexemes." The first category includes lexemes that have a single meaning in Matses, and the second category includes polysemous lexemes. The third category includes names with more than one morpheme, corresponding to Conklin's (1962:123) "unitary complex lexemes" and Berlin et al.'s (1973:217) "unproductive (analyzable) primary lexemes" None of the habitat names include morphemes that refer to a superordinate category, so there are no terms corresponding to Conklin's (1962:123) "composite lexemes" or Berlin et al.'s (1973:123) "secondary lexemes."

One notable trend in Matses habitat nomenclature is that all of the synchronically unanalyzable terms (category 1) are for geomorphologically-defined habitats, suggesting that these habitat names are older than those designating vegetatively-defined habitats. If indeed the geomorphological habitat classification subsystem is older, it is notable that plot it was this sub-system that was more easily classified by the CART analyses.

1) <u>Non-polysemous monomorphemic terms:</u>

tsimpiduc	'valley between hills'
anshantuc	'permanently waterlogged swamp'
nimëduc	'primary forest/undifferentiated primary forest'
mananuc	'upland forest' (usually used with the emphatic ***-quio***)
manan	'hill crest'
macuësh	'hill incline'
mantses	'high levee'
mashcad	'levee island (flooding season term for ***mantses***)'
actiacho	'low seasonally flooded forest'
dëpuen	'stream headwaters'

Possible historical analyses.– The form ***uc*** appears to be a historical locative postposition. The only nouns in Matses that can appear in a locative phrase without a locative postposition are those ending in ***uc*** (these happen to all be habitat terms); so the term ***mananuc*** 'upland forest' is almost certainly historically derived from ***manan*** 'hill crest' and possibly once could be analyzed as 'in the hills'. The term ***actiacho*** 'low seasonally flooded forest' obviously contains the word ***acte*** 'water/river/stream', but the form ***acho*** is not found elsewhere in the language (like *cran-* in English *cranberry*), so it is debatable whether this word is synchronically segmentable.

Matses has a productive but apparently very old process of noun incorporation using abbreviated forms of body part terms prefixed to noun, verb, and adjective roots. The prefix provides a locative orientation in reference to an actual or metaphorical body part. The words listed above are no longer synchronically

segmentable, but the form ***ma*** in elevated topographical terms may be related to the prefix ***ma-*** 'head.' Similarly, the form ***tsi*** in ***tsipiruc*** 'valley'may be the prefix ***tsi-*** 'hips.' And finally, the form ***dë*** in ***dëpuen*** 'stream headwaters' may be the prefix ***dë-*** 'nose'(cf. "upstream" is ***dëbiate-mi*** 'nose-Directional.'

2) Polysemous monomorphemic names

mactac 'mineral lick' also means 'mud'
itia 'upland palm swamp' also refers to the palm species, *Mauritia flexuosa*'

The reason for separating these terms from those in one is that it is not clear which of the meanings for these terms is the older one, making it questionable whether these are old lexemes or recent coining of new habitat names through metonymy. Note that ***nimëduc*** is polysemous in the sense that it refers to categories at two levels of habitat classification ('primary forest' and 'undifferentiated primary forest'), but this polysemy does not bring into question whether this is a recently-introduced term for designating a habitat type.

3) Synchronically analyzable names:

Geomorphologically-defined habitat terms are mostly nominalizations and locative phrases, while vegetatively-defiened habitat terms, especially for primary forest, mostly involve the noun phrase enclitic ***–choed*** 'characterized by,' which is a very productive morpheme that can be used to describe any animate or inatimate entity besides rainforest habitats (e.g., the name for the tayra is ***batachoed*** 'sweet-characterized.by' because it eats fruits and steal papayas; or a man with a large belly may be teased by calling him ***chichanchoed*** 'stomach.parasite-characterized.by'). However, all the terms listed below represent lexicalized terms (they are used consistently, they have restricted meanings, and they are treated differently grammatically from *ad hoc* descriptive phrases).

quiusud-quid rise.above-Agt.Nzr[1]	'non-flooding forest next to a river' (lit. 'one that rises above')
nacnëd-tsë-quid stick.out-Dim-Agt.Nzr	'low levee that is flooded every year' (lit. 'one that sticks out a bit')
sedque-quid shine-Agt.Nzr	'secondary forest from blowdown or river shift with many vines and few *Cecropia* spp. trees' (lit. 'one that shines/is bright [due to sun shining through the open canopy]')
cuëte-uid-quio tabadquid only-Emph stand-Agt.Nzr	'secondary forest where hardwood trees tree-areout competing pioneer vegetation and vines' (lit. 'one where only dicot trees stand')
cuesbud-aid fall.over-Pat.Nzr	'recent blowdown characterized by creeping vines and no trees' (lit. 'fallen over')

acte cuëma-n river edge-Loc	'floodplain forest' (lit. 'beside a river')
acte dada cuëma-n stream body edge-Loc	'gallery forest along a large stream' (lit. 'beside the body of a stream')
acte cuidi cuëma-n stream branch edge-Loc	'gallery forest along a small stream' (lit. 'beside the branch of a stream')
chian cuëma-n lake edge-Loc	'forest along a floodplain lake' (lit. 'beside a lake')
acte mauan river flooded.place	'flooding season term for ***actiacho***' (lit. 'flooded place by a river')
tied shëni swidden old	'secondary forest in abandoned Matses swiddens dominated by *Cecropia* spp. and *Marila* spp. trees' (lit. 'old swidden')
mayu-n tied nonMatses-Gen swidden	'secondary forest from abandoned swiddens or villages >50 yr old' (lit. 'non-Matses Indians' swidden')
mayan-n sebad demon-Gen swidden	'forest with open understory, dominated by *D. hirsuta* trees' (lit. 'demon's swidden')
cuëte mampis dicot.tree ?small	'forest where only thin hardwood trees grow' (lit. 'small dicot trees')
isan-choed Oenocarpus.mapora-char	'forest dominated by *O. bataua* palms' (lit. one characterized by *O. bataua* palms')
niste-choed Iriartea.deltoidea-char	'forest dominated by *I. deltoidea* palms'
shuinte mapi-choed sloth head-char	'forest dominated by *A. tessmanii* palms' ("sloth head" is the name for *A. tessmanii*)
budëd-choed Attalea.butyracea-char	'forest dominated by *A. butyracea* palms'
mio-choed Attalea.racemosa-char	'forest with understory dominated by *A.racemosa* palms'
budëd ushu-choed Attalea.butyracea white-char the name for *A.microcarpa*)	'forest with understory dominated by *A.microcarpa* palms' ("white *A.butyracea*" is

shubu-choed Phytelephas macrocarpa-char	'forest with understory dominated by *P. macrocarpa* palms'
tanac-choed Lepidocaryum.tenue-char	'forest with understory dominated by *L. tenue* treelet palms'
dapais-choed Attalea.phalerata-char	'forest with understory and midstory dominated by *A. phalerata* palms'
cobisan-choed Euterpe.precatoria-char	'swamp dominated by *E. precatoria* palms'
tiante-choed bamboo-char	'forest dominated by bamboo'
sënte-choed Cedrela-char	'forest dominated by *Cedrela* sp. trees'
pëncad-choed tree.species-char	'forest dominated by ***pencad*** trees'
mani pada-choed plantain flat-char	'forest dominated by *Musa* wild banana plants' (lit. 'characterized by having flat [leaved] plantains')
isitodo-choed liana-char	'forest dense with many large lianas'
antin-choed Attalea.maripa-char	'seasonally flooded forest dominated by *A. maripa* palms'
sinad-choed Bactris-char	'seasonally flooded forest with understory dominated by *Bactris* cf. *bifida* palms'
shiuish-choed Ficus-char	'seasonally flooded swamp forest dominanted by *Ficus* sp. trees'
cana shëta-choed macaw beak-char	'low floodplain adjacent to the river with dense thorny vegetation' ("macaw beak" is the name for a species of waterside shrub)
isitodo icsa-choed vine thicket-char	'secondary forest thick with vines and young trees' (lit. 'characterized by vine thickets')
bucu-choed Cecropia-char	'secondary forest dominated by *Cecropia* sp. trees'

acte mactac	'mineral lick in floodplain forest'
river mineral.lick	(lit. 'mineral lick by a river')
itia dapa	'floodplain palm swamp'
palm.swamp large	(lit. 'big palm swamp')
itia mauan	'flooding season term for ***itia dapa***'
palm.swamp flooded.place	(lit. 'flooded place in a palm swamp')

The last three terms listed in this section contain words that are identical to other habitat terms; however, ***mactac*** and ***itia*** are not superordinate categories, but rather occur at the same taxonomic level (and therefore are not "composite lexemes"/ "secondary lexemes."

[1] Morpheme gloss abbreviations:

Agt.Nzr	'Agent Nominalizer'
Gen	'Genitive'
char	'characterized by'
Loc	'Locative'
Dim	'Diminutive'
Pat.Nzr	'Patient Nominalizer'
Emph	'Emphatic'

The Ecological Indian: Myth and Reality. Shepard Krech III. W. W. Norton, New York. 1999. Illus., bibliography, index. $27.95. ISBN 0-393047-555.

Shepard Krech's book *The Ecological Indian* is the best of the works that debunk the concept of "the Indian" or "the indigenous/traditional person" as a natural environmentalist and conservationist, at one with nature. As he puts it: "For while this image may occasionally serve or have served useful polemical or political ends, images of noble and ignoble indigenousness, including the Ecological Indian, are ultimately dehumanizing (p. 26)." As this passage implies, he rejects also the image of the ignoble savage, "cannibalistic, bloodthirsty, inhuman (p. 16)." However, the present book attacks only the nobler image, although the second remains-alas-far more common in popular culture, recent Hollywood movies notwithstanding.

Most of the classic tales of indigenous waste of resources are at least mentioned in this book. Some stories he demolishes, some he credits. The core consists of six detailed case studies that speak to the reality of Native American resource management. These studies have significance beyond the bounds of the book itself.

The first concerns Paul Martin's famous case for humans as the cause of the extinctions of Pleistocene fauna at the end of the last Ice Age (Martin and Wright 1967). Krech does not look with favor on Martin's thesis of a sudden, extremely rapid population increase, followed by rapid migration. (This thesis is now unnecessary, though; evidence for pre-Clovis migration and settlement in the Americas is becoming extensive. Martin can argue, reasonably, for a long slow process, rather than having to insist on a wave of hunters marching in lockstep down the continent singing "Stout Hearted Men.") Krech also notes a singular lack of evidence in the form of kill sites; the *argumentum ex nihil* seems defensible here, because of the sheer volume of archaeological work done in the Americas since Martin's book. We still await a significant number of finds.

Krech also points out that "minifaunal as well as megafaunal animals vanished (p. 38)." The lost include small birds, dwarf pronghorns, storks, and other unlikely game for Paleo-American hunters. Martin's attempts to explain these as all due to human agency are notably lame; some were giant scavengers dependent on megafauna, but most were not. Moreover, the climate of the Americas changed exceedingly rapidly at the time. Pleistocene habitats changed radically. Many have no analogues today. Harrington's mountain-goat, a southwestern species (and a *very* unlikely candidate for hunter-driven extinction), lived in habitats that combined elements now scattered from mountain forest to desert scrub; it could not survive the wringout its plant community broke up. Areas rich in megafauna became hot and dry. Large animals dependent on water would have been wiped out with or without human agency. "Six outher extinction events marked the last ten million years in North America (p. 40)." There had been others earlier. All followed hard on periods of rapid drying.

Krech refers to the inappropriateness of the analogy to recent island extinctions, which took place when people with far more sophisticated technologies entered far more circumscribed, predator-poor environments. I have mentioned

this problem. The Polynesians and other island pioneers brought dogs, pigs, rats, and new pathogens with them; analogy with recent island extinctions makes it certain that these did a good deal of the exterminating. The human invaders can be blamed in some sense for causing the extinction, but it was not really their deliberate bad management that did it; it was their symbionts and parasites.

In short, the Pleistocene extinctions are almost certainly not a simple matter of overhunting. I find it impossible to believe that humans were the main factor, but equally difficult to believe that hunters were not one of the factors. As I see it, diminishing megafauna and increasing human population were clearly on a collision course, especially as drying landscapes concentrated the animals around water holes (cf. Glover 1997). Ambush must have been easy. Management was difficult; the hunters would have had a hard time working out a plan, because every year the game diminished from natural causes. No doubt the hunters overshot in more ways than one.

Krech also provided a solid and reasonable review of fire in traditional Native American management. Krech, however, paid too much attention to large-scale prairie fire and less to the more carefully controlled and targeted burning that is known in California, the Northwest Coast, and other western landscapes. He considers all the evidence carefully, but provides much more detail on the more destructive cases. He might have profited from comparison with Australia, where set fires probably helped exterminate large marsupials (Flannery 1995) but has proved essential to the survival of many small ones (Nowak 1999; Pyne 1991).

Much less defensible is Krech's stand on buffalo hunting. As he points out, the Indians at least left 60,000,000 buffalo on the plains for the white men to eliminate in the late 19th century. But, he maintained, the Indians wasted bison. This they did largely through the "buffalo jump": Driving herds over cliffs and ravine rims. It undeniably involved a great waste of bison. However, Krech almost certainly exaggerates the extent of this. Reading his work, one cannot escape the conclusion that, every time an Indian wanted a light snack, he drove a million buffalo over a cliff. The truth is more complex. For one thing, before the horse and gun, there were very few Indians on the plains. For another, not every jump got a million buffalo at a time-most managed to get very few indeed. For another, driving a herd of buffalo is exceedingly difficult even with the horse and gun; for tiny roving bands operating on foot, it must have been almost impossible. It would have, at the very least, taken the whole group a great deal of time to organize it. One would expect buffalo jumps to be very rare. This is indeed the case. Krech cites the displays at the Head-Smashed-In Buffalo Jump in Alberta as a source, so he is surely aware that those displays point out that there was only about one successful jump per quarter century. Other sites have even fewer jumps. Many were used once only. Of course, once a herd starts over a cliff, it may stampede, leading to the deaths of many times more buffalo than a group could possibly butcher and utilize. Evidence, however, suggests that such a mass kill was a rare event. (Was it viewed as a tragedy?) Much more often, only a few buffalo went down, and these were more or less thoroughly used. Of course, the Ecological Indian of Hollywood stereotype would probably not have used the jump method at all.

One main theme of Krech's book is his contention that the concept that the

Native American concept of rebirth of animal souls allowed the Indians to kill without compunction. Virtually universal in native North America is the theory that animal souls are immortal; when one animal body dies, the soul goes to seek out another. This is taken by Krech as a license to kill. What Krech ignores is that in every well-documented case known to me-and I have worked with several Native North American groups and have read mythology or ethnographic data from all of them-this theory is used as a justification for good management. Usually it is explicitly so used. The souls are believed to go elsewhere, or to refuse to reincarnate at all, if humans treat the animals with disrespect-and the worst form of disrespect is deliberately taking more than one needs. Weirs that block whole rivers, slaughter of whole herds of game, trapping out whole populations of beaver, and other such overdrafts on the resource base are prohibited; such offense makes the spirits go elsewhere. In addition, most groups have concepts of Masters of the Game, or leader animals, or some such supernaturally powerful animals that watch over the animal beings and punish humans who overhunt. As a conservation measure, this is hopelessly inadequate in an age of shotguns, but it is reasonably effective in a simpler, less heavily armed economy. I know this because it is still very much alive and taken very seriously in the area where I now work, the Maya communities of the Yucatan Peninsula. It still operates to reduce hunting pressure very substantially. Overhunting goes on, but at least some game survives.

Krech's next case is that of the beaver, and here he reaches still farther out-though, again, he is careful to assign the worst blame to European enterprise for trapping the beavers out, and to luring the Native Americans to do most of the dirty work. But he seems to maintain that unchecked waste of beaver was aboriginal. This is difficult to believe. Traditional Native American ideology of beaver conservation is too well-documented and widely documented to deny; it is still a feature of life in Canada. However, Krech follows the very shaky arguments of Robert Brightman (1993), who indeed found this conservation ideology, but maintained it was a result of teaching by early fur traders and other white outsiders. The obvious problem with this is that Brightman, and Krech, rely largely on the testimony of fur traders who were trying to explain to the home office why furbearer numbers were thinning out. Blaming the Indians, who were claimed to waste beaver in spite of all the traders' diligent directions to the contrary, was an obviously rather self-serving story. Perhaps it was true, at least locally. But the conservation ideology of the Indians, as documented by Brightman and virtually all other ethnographers, is the same general belief system that one finds from the Koyukon of Alaska to the Maya of Quintana Roo. It is encoded in myth and ritual all over the continent. It did not come from the fur traders. Nor do I believe that many fur traders were seriously interested in conserving the resource. They were, indeed, rather more prone to forestall rival groups by deliberately trapping out all beaver over vast areas. In a single expedition, Peter Skene Ogden led a party that exterminated the beaver from most of Oregon and northern California (Ogden 1987, orig. ca. 1827). The protestations of early writers, and their blame of Indians (whom they tended to regard as drunken and bloodthirsty savages), ring rather hollow. Conversely, to maintain his theory, Krech is forced to dismiss virtually all

ethnographers, from Frank Speck to Harvey Feit, as hopeless romantics in the grip of the Ecological Indian stereotype. Never mind that Speck and many others wrote at a time when the stereotype of the Ignoble Savage was overwhelmingly dominant and the Ecological Indian lay in the dim future.

On the Northwest Coast, I found that the concrete management strategies and the real awareness of how to use the environment were found most strongly among the very traditional men and women, many of whom spoke little English. By contrast, the glib generalities of the "ecological Indian" sort were indeed found mainly among the young and English-educated. So the rhetoric may be learned, but the substance was old.[1] In Mayaland, there is no conservation rhetoric to copy; Mexican rural development strategy is still overwhelmingly focused on destroying nature and everything natural just as fast as possible. Thus, it is safe to ascribe any Maya teaching or behavior that is ecologically or environmentally aware to genuine tradition.

Books that paint the Native Americans in a good light-from frankly Ecological Indian sources (e.g. Hughes 1983) to more scholarly work (Berkes 1999)-focus on the best of ideology: on myth, cosmology, and teaching. Certainly, it is undeniable that all Native American peoples were intensely conscious of their environments, and encoded incredible amounts of knowledge-both pragmatic and "religious"-in their myths, tales, and cosmological teachings. Yet, as Krech points out, such people often compare the best of Native ideology with the worst of Western practice. Conversely, books that slant toward an Ignoble Savage view, such as Krech, and those that take this view to an extreme, including such intemperate writings as those of Martin Lewis (1992), Rod Preece (1999) and Matthew Ridley (1996), focus on the worst of practice: on overhunting, over-irrigating, overburning. These latter writers have varied political agendas. Lewis intends to defend moderate political positions against those who see a need to dismantle western civilization wholesale. I agree with him-in fact, that is the theme of the present book too-but he had no need to trash the indigenous peoples in the process. Preece, who writes with the equally worthy goal of redeeming western civilization from charges of being anti-environment, unfortunately ruins his case by comparing the best of Western ideology with the worst alleged indigenous practice.

Comparing best ideology with worst practice in 20th century America, one would see a gap between the writings of John Muir, Rachel Carson, and Stewart Udall, on the one hand, and on the other the area of wilderness paved, the number of species exterminated, and the acres of forests permanently destroyed.

What is the truth? Muir and toxic waste dumps were both a part of America in the 20th century, and there was a great deal in between. The Native Americans too have a diverse record.

These negative authors do not consider the superb management of resources that is extremely thoroughly documented for Pueblo agriculture, California plant management, Northwest Coast fisheries, and Maya swidden agriculture (except for the Late Classic overcut!). But, on their part, the Ecological Indian writers delicately write around the issue of human frailty: the fact that the spirit may be willing, but the flesh is weak. Moral standards are normally made to be impossibly strict, since moralists are sadly aware that people almost always fall short of

precept. If one prohibits overhunting, one can hope to reduce it, but not to eliminate it.

These matters are highly political. The Ecological Indian theory, if taken seriously, might lead to giving Native Americans unlimited power over their own resources. This might have most unfortunate consequences. In a few limited areas, it is indeed having such consequences already (see Terborgh 1999; and I have encountered the problem in a few Third World cases).

Conversely, the Ignoble Savage theory was and still is a quite open and calculated justification for depriving indigenous people of their lands and resources. Clearly, people who wander about on the land, burning forests and thoughtlessly exterminating game animals, are not exerting any "true" property rights; they should be driven off the land for their own good, since all they do if left in control is ruin the land for everyone else. This logic is still common in the United States and Canada-I have heard it countless times from ranchers, conservation biologists, fishermen and many others-and is even more frequent in Third World countries, where I have found it in control of local policy from Malaysia to Mexico (cf. Ascher 1999).

It is interesting to contrast modern works on both sides with the classic ethnographies from the days when anthropologists were trying to document the facts, as well as the statements of the Native Americans themselves. Those ethnographies revealed the Indians to be superbly aware of their environments, and good but not perfect resource managers. The extreme polarization, in both directions, is a new thing for anthropology-but, alas, all too well-worn a groove for politicians.

NOTES

[1] Krech makes a common mistake among anti-Indians of maintaining that Chief Seattle's famous environmentalist speech, originally made in the 1850s, was a fake. It was, in fact, real. However, it was heavily larded with fuzzily Christian rhetoric in a semi-fictionalized rewrite in 1970-71. The exact words of the speech have been lost, but early versions agree on included Chief Seattle's militant defense of his land, supported by some concrete and specific environmental details. The remake added some general, fuzzily-virtuous sentiments, but did not radically change the sense of these particular passages. See Kaiser (1987).

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ETHNOECOLOGY OF WHITE GRUBS (COLEOPTERA: MELOLONTHIDAE) AMONG THE TZELTAL MAYA OF CHIAPAS

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ABSTRACT.– A participatory study of white grubs of the family Melolonthidae among the Tzeltal Maya recorded traditional knowledge of this pest, and also maize cultivation practices utilized for deliberately or not managing the populations. This group of farmers has an ample knowledge of the bioecology of Melolonthidae present in their community. They know major life stages, and also natural enemies of larvae and adults, as well as the host plants used by the latter. Recorded agricultural practices that can reduce the damage caused by grubs include preparation of the fields; sowing; and hilling up soil around the plant. We contrast the knowledge of this Tzeltal group with knowledge generated by bioscientific methods, to make it possible to integrate and render the Tzeltal methods useful in possible programs for sustainable pest management.

Key words: White grubs, Melolonthidae, corn, Tzeltal Maya, Chiapas, traditional knowledge

RESUMEN.– A través de una metodología participativa se registró el conocimiento tradicional que un grupo maya-tzeltal posee acerca de la gallina ciega (Coleoptera: Melolonthidae) y las prácticas agrícolas del cultivo del maíz que realiza para el manejo de las poblaciones de la plaga. Este grupo de productores tiene un amplio conocimiento de la bioecología de los Melolonthidae que se presentan en su

comunidad; conocen su estacionalidad y la de los enemigos naturales de larvas y adultos, así como las plantas hospederas de estos últimos. Las prácticas agrícolas registradas que tienen un efecto en el daño causado por gallina ciega son: preparación de los terrenos, la siembra y el aporque. Adicionalmente se contrasta el conocimiento de este grupo maya-tzeltal con conocimientos generados por el método científico, a manera de integrarlos y hacerlos útiles en posibles programas de manejo sustentable de plagas.

RÉSUMÉ.– Une étude participatoire sur le vers blanc de la famille Mélolonthidae parmi les Tzeltal Maya démontré une connaissance traditionnelle de ce parasite et des pratiques en matière de culture de maïs utilisées pour contrôler ces populations. Ce groupe de fermiers a une ample connaissance de la bio-écologie des Melolonthidae dans leur communauté. Ils connaissent les étapes principales de la vie de l'insecte, les ennemis naturels des larves et des adultes, ainsi que les plantes parasitées par les adultes. Les pratiques agricoles décrites ci-dessous qui peuvent réduire les dommages provoqués par le vers comprennent la préparation des champs; le nettoyage des mauvaises herbes; l'encemencement; et la formation de monts de terre autour de la plante. Nous contrastons le savoir de ce groupe Tzeltal avec les connaissances produites par des méthodes scientifiques, pour permettre l'intégration et l'utilisation des méthodes Tzeltal dans de futurs programmes de lutte antiparasitaire.

INTRODUCTION

The highlands of Chiapas have hosted, for more than 500 years, a rural population of Tzotzil and Tzeltal Maya (de Vos 1980). Their deep-rooted history has given them wide experience and knowledge of local resources. Part of this traditional knowledge has been recorded in the ethnobotanical work of Berlin et al. (1974, 1990), and the ethnozoological work of Hunn (1977), on Tzeltal folk classification.

However, there is more to be said about perception of Melolonthiids among the Tzeltal. Farmers of the Chiapas highlands refer to these insects as ***k'olom*** (Tzeltal Maya), ***k'onom*** (Tzotzil Maya) or *gallina ciega* (Spanish; lit. "blind chicken"). These organisms are the principal cause of losses to grain, vegetable, fruit and flower culture in the area (Ramírez et al. 1999). There is evidence (Ramírez and Castro 1997) that the level of damage caused by Melolonthiids in this region is similar to that recorded elsewhere in Central America (Quezada 1980; Ríos-Rosillo y Romero-Parra 1982; Rodríguez del Bosque 1988; Morón 1993). However, we do not know precisely which species are pests in the area, nor do we know enough about their biology to propose a pest management plan with optimal possibilities for success (Morón 1986, 1993). Most of the literature on Mexico's agricultural pests says that the name covers some eight species, but actually there are over 560 soil-dwelling larvae—root-eating, saprophagic or facultatively either—in the *"gallina ciega"* complex (Deloya 1993; Morón 1983; Morón et al. 1996).

Until now, no one seems to have studied ethnozoological aspects of scarab beetles in Mexico (Morón et al. 1997), still less the *gallina ciega*. We have only a few notes on consuming them as food (e.g. Ramos and Pino 1989: 21). As noted above, we consider it important to conduct ethnoecological studies on rural and indigenous knowledge of the Melolonthidae. Empirical knowledge might be very useful

in developing strategies of management for these pests, and for conservation of other species in the same family.

Ethnoecology, like many other disciplines, has a role in community development. This discipline records traditional wisdom in a systematic manner, and relates it to productive practice as well as to global economy and to the world of rural cultivation (Vásquez 1992). Bentley (1992) notes that technical collaboration with rural people should be based on what they know (or do not know), including what they might need to learn, teaching it in such form that it can be consistent with what they do know, and can learn in a manner that allows synthesizing the new information with the old. With this view, we carried out the present work, taking into account also the point that success in sustainable pest management is based on a broad technical knowledge and/or traditional knowledge of the agroecosystem. Our objective was to record and analyze knowledge of Melolonthidae, and of maize cultivation practices for managing white grub populations thereof, among the Tzeltal of Balún Canal, Chiapas, Mexico. Additionally, we evaluated the possibility that this knowledge could be integrated with strategies for sustainable management of these grubs.

The Study Area.– This investigation took place in the community of Balún Canal, in the *municipio* of Tenejapa, Chiapas (a *municipio* is roughly equivalent to a county or township). This locality lies 22 km east of San Cristóbal de Las Casas, at 16 46′ 49″ north and 92 32′ 12″ west. It is some 2240 m asl. It has a temperate, subhumid climate with summer rain (C[w_2][w]), with temperatures around 14-16 C. The vegetation of the zone includes cultivated areas (principally maize and beans), and fragmentary remnants of oak-pine and montane mesophyll forest (based on data from the Laboratorio de Información Geográfica y Estadística de El Colegio de la Frontera Sur, 1997).

The Tzeltal of Balún Canal.– The population of the community is composed of Tzeltal Maya. As of 1990, there were 500 persons distributed in 80 households; 47% were male, 53% female; 35% did not speak Spanish (INEGI 1990).

In the same year, 45% were listed as economically active. Most (92%) were involved in primary production, principally maize cultivation (INEGI 1990). The fields were slash-and-burn, used intensively for two years. They were prepared for sowing in late winter and early spring. Sowing was done before, or at the beginning of, the May rains. The maize was harvested in autumn or the first part of winter. Because of the scarcity of cultivable land, as well as low yields and problems with erosion and pests, the Tzeltal megibrated seasonally to work for pay in the coffee plantations or cattle ranches of Chiapas (Robledo 1994).

The Melolonthid pests.– The term *gallina ciega*– literally, "blind hen" or "blind chicken"– is the common Spanish term for larvae of beetles of the family Melolonthidae. It also includes some Scarabaeid larvae, and other subterranean pests. According to Morón et al. (1997), this name has no known origin, and no equivalent in other languages. They note it may have arisen during the first years of Spanish colonization. The only relationships between these larvae and the name "blind chicken" seem to be their lack of conspicuous eyes and the possibility of their being eaten by chickens.

The Melolonthids go through a full transformation: egg, larva, pupa and adult. This cycle can take one to seven years depending on their geographic position. Most tropical species have cycles that are annual or biennial depending on environmental conditions (Villalobos 1995).

Larvae of Melolonthids are often associated with grasses, legumes, rosaceous plants, and plants of the nightshade family (Morón 1984, 1986). In Mexico they have attacked roots of maize, beans, sorghum, wheat, potatoes, rice, sugarcane, strawberries, carrots, spinach, tomatoes and onions (Morón 1984; Rodríguez del Bosque 1988). Damage can be light (15% or less of roots), moderate (up to 40%), or severe (over 40%), depending on cultivation, environmental conditions, and state of development of the insect at a particular time (Villalobos 1995). The third larval stage causes the worst damage (Morón 1984).

METHODS

Because of criticisms of ethnoecological investigation, especially its methods (Vásquez 1992), we decided to modify and/or enrich the investigation with new techniques for recording knowledge. Particiaptory investigation can be very useful in that it proposes strategies focused on participation of a larger number of agents involved in the process of investigation.

The community of Balún Canal was chosen due to the favorable disposition of the people and to earlier data on knowledge of the grubs that the people had provided before the investigation. Most of the heads of families were involved in a society called "New Balún Canal," an informal organization (not officially registered). This made it easy to work with participatory methods.

Field work was done from January to September of 1997, through 35 visits to the community, each one lasting two days and involving a Tzeltal interpreter. We held participative workshops and used various data-gathering techniques, such as direct observation and group interviews. We interviewed key informants in the course of informal conversation, and also gave guided and open-ended but standardized interviews. We will proceed to describe various techniques used for recording data.

Participatory workshops.– We held four bimonthly meetings with members of the "New Balún Canal" society, which included 54 heads of families. At the first workshop, with 32 persons (some being absent for wage labor), we explained the research. The intention of the meeting was to motivate those present to participate actively in the investigation.

In a second workshop, with 40 persons, the theme was the cultivation of maize and the activities involved in it. Systems of maize phenology were laid out, as were names for each phenological stage, and activities during the agricultural cycle.

The third meeting (49 persons) served to make known the principal pests affecting maize cultivation. We used pictures of maize plants; participants wrote down or indicated the organisms and the affected part of the plant. Individuals voted for pests considered most damaging. Thus we developed an ordered list of the five principal pests.

In the fourth participatory workshop, 30 members of the New Balún Canal

organization worked on knowledge of larvae and adults of the Melolonthidae specifically. They were presented with larvae and pupas preserved in alcohol, and adults mounted on pins, to elicit classification and nomenclature. They were shown larvae of Melolonthidae of different subfamilies (Dynastinae and Melolonthinae), Scarabaeids, and other soil-inhabiting insects (Coleoptera: Elateridae; Lepidoptera; Noctuidae; Diptera), to elicit grouping and differentiation. Also they were presented with adult scarab beetles collected in the area, and also with other scarabs (Cetoniinae and Scarabaeidae) that could be confused with them. Once these organisms were classified, we wrote up on a sheet of cardboard the ecological attributes belonging to these organisms: where and how they live, what they eat, what enemies they have. When the Tzeltal referred to natural enemies, they were shown pictures of the animals (Hunn 1977), to make a more precise identification of the species to which they refer.

Group interviews.– These interviews involved local people directly involved in maize cultivation. As part of these activities, we encouraged conversations and interchange of ideas and information about the grubs. During these interviews, we worked with an average of 15 participants, to facilitate application of participatory techniques such as going over field inspections with them, elaboration of diagrams, and group discussions.

Interviews with key informants.– With the purpose of getting different perspectives on the problem of the grubs, interviews with key informants were given individually to 13 persons of different ages. These persons were selected in the workshops, in accord with their participation and knowledge. With them, we went deeper into their knowledge of the biology, ecology and classification of the grubs. We also took up aspects of maize cultivation practices that intentionally or unintentionally managed populations of the insects. The value of this type of personal interview is that it avoids bias that can occur in group interviews. Biases can occur in these groups when expression of real opinions is inhibited.

Direct observation.– This technique consists of observing intensively and systematically the management of the grubs in maize cultivation. Information obtained in the field was contrasted with information obtained in the workshops and interviews. As part of this activity, visits lasting two to eight days per month were made. Most visits to field sites lasted four days. Data thus obtained was organized and presented in the form of an agricultural calendar of maize cultivation.

Collection of entomological specimens.– We collected 320 specimens of soil (288 in nine fields and 32 in woodland near the community). Larvae of the *gallina ciega* complex were collected *in situ*, in unit sample of soil specimens (monoliths of 15 cm diameter by 20 cm depth), during February and March. Adults were captured in March to June (their flying period), using a light trap. Additional adult beetle material was obtained during a check of trees and bushes known to be wild host species, during twilight and early night (19:00-22:00 hours). Collections were made together with farmers, so as to collect more precise ethnoecological data. Also, we collected specimens of plants used as perches or host plants. Natural enemies were also captured, as were other soil-inhabiting larvae encountered. All this material

was sent to specialists for adequate taxonomic determination, and deposited in the collections ECO-TA-E, M. A. Morón and B. Gómez.

Contrast and analysis of knowledge.– Contrast and analysis of traditional and scientific knowledge was done in a qualitative method, using comparative tables.

RESULTS AND DISCUSSION

Taxonomy.– One hundred percent of the Tzeltal farmers referred to the grubs as ***k'olom***. We do not know whether this word has any other significance. The Tzeltal can distinguish Melolonthid larvae from other soil larvae such as Noctuid moths (***wajchan***) and Diptera (***me'toyiw***). However, they cannot differentiate Scarabaeid from Melolonthid larvae, possibly because of their morphological similarity. In Mexico in general, *gallina ciega* applies to Scarabaeids, which suggests the term is equivalent to ***k'olom***.

In contrast, the Tzeltal differentiate the adults: Scarabaeids are ***kutuntza***, Melolonthids ***chimol*** or ***umo'*** (Table 1). This finding differs from Hunn's (1977:295-297); he found that the Tzeltal used the term ***kuhtum ca*** for certain Scarabaeids (Geotrupinae) and Melolonthids (Cetoniinae). Hunn suggests that ***cimol*** is the word for rhinoceros beetles (Melolonidae: Dynastinae; possibly the species *Xylorictes thestalus)*. He notes that the word ***umoh*** is utilized for June beetles (we think the genus *Phyllophaga* is meant and other similar twilight-flying scarabs (possibly *Anomala)*. He mentions that "***cimol, umoh*** or ***kuhtum ca***" are the same (see Hunn 1977:297). They use the terms as synonyms for any adults of the *gallina ciega* group. Our differences from Hunn may be due to the fact that we worked in one community, while he worked in various Tzeltal communities. It is true that in other Tzeltal communities one can encounter other names; in El Madronal (Amatenango del Valle) the name ***xkumuk*** is used (Ramírez and Castro 2000). Also, we find that the older name was ***umo'*** and today the term ***chimol*** is more often used, since approximately the 1950s. This change has come about because of migrants from other communities, Tzotzil as well as Tzeltal. The name ***chimol*** or ***umo'*** includes at least the following species in the community studied: *Phyllophaga obsoleta, Anomala sticticoptera,* and two possible new species: *Phyllophaga* sp. 1 group *Phytalus,* and *P.* sp. 2 group *Anodentata*. However, it is possible that other species of adult Melolonthids have no special name. These are: *Hoplia mexicana, Xylorictes thestalus, Cyclocephala alexi, Phyllophaga* sp. 3 group *Schizorhina,* and *Ancognatha sellata*. The larval phases of these are possibly included in the *gallina ciega* complex. The species that possess a name in Tzeltal during their adult phase are those which were sometimes consumed by local people, and/or species that come in great numbers around houses, attracted by lights. However, some species that inhabit forested land have no name (Gómez et al. 1999a).

In this context, it must be emphasized that ***k'olom*** is the term used in most of the Tzeltal region for the larvae stage. Scarabs possess different names in the various communities of the Tzeltal region: ***chimol, umo', xkumuk'***. Berlin (1973) notes that in folk classification, when a name goes beyond its geographic limits and extends to a wider region, it is because the term has gained a large cultural signifi-

TABLE 1.– Designation in Tzeltal of Balún Canal, Chiapas; Spanish; and English for scarabaeiform beetles and larvae.

Description	Tzeltal	Spanish	English
Larvae of Melolonthid and Scarabaeid beetles	***k'olom***	*gallina ciega*	beetle grub, white grub
Adults of Melolonthid species mentioned	***chimol, umo'***	*ronrones, escarabajos de Junio*	beetles, scarabs, June bugs
Adults of Scarabaeids (*Geotrupes* sp., *Copris* sp.)	***kutuntza***	*Escarabajos, estiercoleros, "rodacacas"*	beetles, scarabs, dungbeetles

cance. The wide use of the name ***k'olom*** can be attributed to the importance of the insect as a pest of maize.

Bioecology.– Development. Apparently, the Tzeltal community studied ignore fundamental aspects of the process of metamorphosis. However, 100% of the 13 persons interviewed know that ***chimol*** or ***umo'*** adults are the progenitors of the larvae (***k'olom)***. They suppose that these proceed from eggs of the ***chimol*** or ***umo'***. Only two of the 13 know that the larva goes through a pupal stage. They have observed that from these "little balls in the ground" (as they call them) issue adult scarabs. The few people who know the pupal stage and relate the different stages to the adults are persons of advanced age. It is possible that the above follows from the relative short duration of the pupal stage—30-45 days in *Phyllophaga* according to Morón (1986). One could also argue that the pupal phase occurs when the soil is resting and the Tzeltal are not active in the fields, and because of this cannot detect the pupae.

Life cycle. – It is evident that the Tzeltal of Balún Canal have knowledge of part of the life cycle of these scarabs. However, they cannot recognize the distinct larval instars or (usually) associate the pupae with the life cycle. Also, during the third workshop, 100% of the participants agreed that the duration of the life cycle is one year. Those interviewed mentioned that each year there are larvae as well as adults, and that they occur in similar abundance each year. The group mentioned that the larvae are present in the maize fields during nine months of May to February, and reported that the greatest abundance of larvae occurs in August. The farmers also noted that the adults fly from March to June. They have observed that adults fly during a period of one to three hours, starting around 19:30 to 20:00 p.m. The foregoing fits with results of scientific research in highland Chiapasm Mexico (Ramírez and Castro 1997) and other countries of Central America (Lastres de Rueda 1996; Méndez et al. 1996; Mendoza 1996), and can be compared with field observations (Table 2).

Host trees and perch sites. – In the third workshops, we found that 100% of participants knew that the ***chimol*** or ***umo'*** eats leaves of the *ajil* or ***jnak*** *(Alnus acuminata*

TABLE 2.– Comparison of information obtained in this study with that reported in biological research in the area or in similar areas

THIS STUDY		OTHER INVESTIGATIONS
Time of larvae	May - Feb.	7 May - 10 Jan. (Ramírez and Castro 1997)
Time of major damage	August	July - August (Ramírez and Castro 1997; Lastres de Rueda 1996; Mendoza 1996; Méndez et al. 1996)
Density of larvae in roots during critical period	44 indiv/m^2	38 indiv/m^2 (Gómez et al. 1999b)
Time of flying of adults	March - June	April - May (Ramírez and Castro 1997); April - June (Gómez et al. 1999a)
Hour of flight	19:30 - 22:30	19:30 - 21:00 (Ramírez and Castro 1997); 19:00 - 23:00 (Gómez et al. 1999a)
Spatial distribution of the larvae during period of attacks	patches	patches (King and Saunders 1984)
Life cycle	1 year	Univoltine, 1 year (King 1996)

ssp. *arguta,* Betulaceae) and the ***chiquinib*** (*Quercus crispipilis,* Fagaceae). In accord with what is reported for other Melolonthidae, another host tree of *P. obsoleta* could be *Erythrina americana* (Fabaceae; Morón 1997). 70% of the Tzeltal mentioned plums, peaches and pears as possible hosts. However, we observe that these trees do not become defoliated and are used only as perch sites by the scarabs. Host plants identified in other work (Gómez et al. 1999a) that are not recorded as part of traditional Tzeltal knowledge are ***siban*** (*Cornus excelsa,* Cornaceae—used in the community for firewood); ***tujkulum chix*** (*Solanum myriacanthum,* Solanaceae), whose spines can wound people in the woods; and *Senecio sancristobalensis* (Compositae), which lacks a local name, possibly because it lacks use or importance for this ethnic group. These three species are probably not part of the Tzeltal's store of scarab knowledge because they grow in the woodlands and are visited by the scarabs at night (Gómez et al. 1999a), outside the view of the Tzeltal.

Habitat. – The Tzeltal know that the ***k'olom*** occurs in different habitats. They have observed that these larvae live in agricultural or forest soils, and that on various occasions it is possible to find them in rotting treetrunks. Similarly, they note that the larvae eat roots of maize, beans, potatoes, and various trees, as well as rotten trunks and decomposing leaves in the soil of the woodlands. The scientific literature, and observation during the present study, suggest that the habitats of the various species of *gallina ciega* are different. *Phyllophaga obsoleta* and *Anomala sticticoptera* are principally associated with agricultural soils (King 1996; King and Saunders 1984; Morón 1988; Morón et al. 1997; Ramírez and Castro 1997), while

the rest of the species appear to be confined to forest soils (Morón *et al.* 1997; Ratcliffe and Delgado 1990).

Natural enemies. – The workshops and interviews indicated that various enemies are recognized (Table 3). The Tzeltal have observed that the larvae are consumed by animals such as the skunk (***pay***), armadillo (***majiltibal***), pig (***chitam***), domestic fowl (***me'mut***), and various wild birds (***tetikil mut***), especially the great-tailed grackle (***jojmut***). The Tzeltal of Balún Canal recognize as predators of adult Melolonthidae the domestic dog (***tz'i***), the cat (***xawin***) and the wildcat (*cis balan*). This suggests that the combined effect of domestic and wild animals animals could contribute to the regulation of grub populations.

With data collected in the fields, we could determine other less conspicuous natural enemies, unknown to the Tzeltal. These include a fungus, *Beauveria bassiana* (Deuteromycetes), and a wasp, *Pelecinus polyturathor* (Hymenoptera). The lack of Tzeltal knowledge of such small or microscopic natural enemies is explained by Bentley (1992). This author mentions that size can be a limiting factor in traditional knowledge. Moreover, Hunn (1977) suggests that the low density of solitary wasps like *P. polyturathor* can explain why they have no names in the community.

Use of Melolonthids for human food.– During the larval phase, Melolonthids are not eaten by the Tzeltal, and have no use in the area studied. In earlier times, there was a custom of eating scarabs toasted on a *comal* (flat griddle). This habit continued until about 30 years ago. Today, few eat these beetles;[1] the custom has gradually been lost. A possible explanation is that the Tzeltal, in constant contact now with industrial products, have changed their foodways. This phenomenon could be an indicator of change in the quality of life among the Tzeltal, due to the introduction of new types of foodstuffs, leading to a decrease in the value placed on natural foods obtained in the fields. We have observed that, in the community studied,

TABLE 3.– Principle Natural Enemies of the Melolonthids Observed by the Tzeltal of Balún Canal, Chiapas

Tzeltal name	Spanish name	English name	Scientific name	Phase eaten
Pay	*zorillo*	skunk	*Mephitis macroura* and ?*Conepatus mesoleucus*	larvae
Mayiltibal	*armadillo*	armadillo	*Dasypus novemcinctus*	larvae
Chitam	*cerdo*	pig	*Sus scrofa*	larvae
Me'mut	*gallina*	fowl, chicken	*Gallus gallus*	larvae
Jojmut	*zanate*	great-tailed grackle	*Cassidix mexicanus*	larvae
Tz'I	*perro*	dog	*Canis familiaris*	adults
Xawin	*gato*	cat	*Felis domesticus*	adults
Cis balam	*gato de monte*	margay	*Felis wiedii*	adults

consuming adult Melolonthids are looked down on—it indicates low status. We do not know what effect this change may have had on increases of the populations of *gallinas ciegas*. Ramos and Pino (1989) record the consumption of *Phyllophaga* by Nyahnyu (Otomi) and Nahua in some regions of Mexico, but as larvae or pupae. Hunn (1977) notes that the Tzeltal eat ***chimol***, but does not record which species. The results of our workshops and interviews suggest that the species were *Phyllophaga obsoleta, P. sp.(Phytalus)* and *P.sp.(Anodentata)* (Gómez et al. 1999a).

Agroecology.– In this section we present and discuss findings on certain agroecological aspects of the cultivation of maize (***ixim***) relevant to consideration of the grubs.

Agronomic importance of the *gallina ciega*.– Twenty-eight percent of 49 farmers interviewed in the second workshop stated that the grubs are the most important pest of maize. However, 30% considered that first place belonged to the gopher (***baj***, *Heterogeomys sp.*). Still others had other opinions: 17% voted for corn borers (***wajchan***, Lepidoptera), 17% for rats and mice (***ch'o***), and 8% for squirrels (***chuch***). These results suggest that the ***k'olom*** is the principal invertebrate pest of maize. However, there is no special form of control, except cleanup by hand or with a hoe.

According to those interviewed, symptoms of damage by grubs are yellowing and *acame* of the plants; *acame* is a local term for blowdown (falling over of plants due to root loss followed by wind). Damaged shoots can easily be pulled from the ground. Nearby soil is then examined; about three to five grubs can be found per plant. 100% of the Tzeltal mentioned that damage is present year after year, at the same level, in patches in the fields. The period of the most severe attacks is August (Figure 1). Symptoms of damage are similar to those recorded in field work elsewhere in Mexico and Central America (Table 2).

Calendar and agricultural practices.– The Tzeltal of Balún Canal have a calendar for their c activities (Table 4 and Figure 1). This calendar is flexible, exact dates being determined by environmental conditions prevalent in a given year. Berlin et al. (1974) observed a calendar similar to that reported in the present study. In this calendar, the agricultural cycle is strictly correlated with a "Tzeltal native calendar" (Figure 1).

The farmers of the community carry out agricultural practices that can have positive or negative effects, deliberate or unintended, on the grubs. Four—preparation of land, cleanup, sowing, and hilling up soil around stalk bases (the *calzado* or *aporque*)—can have a negative impact on grub damage.

Land preparation. – The farmers state that preparing the soil (see Table 4) lets them loosen the ground, eliminate weeds, and kill potentially damaging organisms. Thus this practice permits better drainage and exposes the larvae of Melolonthidae to attacks by their natural enemies, reducing their populations. The former was also observed by Musick and Petty (1974, cited in Carballo 1996), who mentioned the negative effect that soil preparation had on the grubs.

Sowing. – Sowing of maize (Table 4) follows the initial cultivation. One hundred percent of the farmers stated that the sowing consists of putting 4-5 seeds in each hole. Sowing follows a more or less definite pattern: holes are made a meter apart

(in each direction). If this is done well, it is not thought of as a control measure, but it reduces the problem of grubs. The strategy can reduce damage by increasing the biomass of the maize root system. The plants can sustain more wind action, reducing *acame*. It is possible that the plants can compensate better for root-eating activity in comparison with isolated individual stalks. Indeed, some plants affected by

TABLE 4.– Agricultural activities; their stated purposes; their possible effects on management of grubs

Activity	Description	Objective	Effects on *gallina ciega*
Preparation of the land	If the field is being cultivated for the first time, or after a long period of abandonment, slash-and-burn cultivation is used. If the field has been used recently, it is cleared by hand or with hoes. Then the soil is moved, with manual elimination of pests.	This clears the land to create a biotic and abiotic environment favorable for cultivation.	Grubs are eliminated as found, being killed by foot or hoe, or leaving them exposed to birds and sun.
Sowing	4-5 seeds are placed in a hill. This establishes cultivation.	Sowing several seeds strengthens the support system of the plants.	They can then better withstand the root-consuming activity of grubs and other soil pests.
Cleanup	Weeding, manually or with hoe. Only one person (of 10 interviewed) used herbicides.	This reduces competition by weeds, and improves visibility in the field.	It possibly diminishes the densities of grubs
Hilling	This involves hilling soil and organic material around the base of the maize plant, using hands or hoe.	It provides a more solid support for the plants, preventing blowdown. It also maintains the humidity of the soil around the maize stalk.	It is a form of fertilization that can diminish the damage by grubs through incorporating more available nutrients in the root zone.
Doubling over	Plants are bent over, at ca. 1.3 m above ground.	This is done to avoid rotting of maize in the ear through humidity due to rains. It also reduces blowdown and bird damage.	It has no known effect on the grubs.
Harvest	Ears are collected and taken to a secure place. Removing grains from ears is done just before consumption or utilization of the grain.	This allows utilization of the product.	It has no evident effect on the grubs.

blowdown because of late grub damage can still render normal ears of corn and can be harvested.

Hilling up. – This is an activity (Table 4) carried out by the Tzeltal to give more firmness to the plants in the face of wind and rain. With this practice, consciously or unconsciously, the farmers avoid blowdown provoked by weakening of the root system by soil pests such as the grubs. This activity is done just before the damage becomes evident (May-June).

The Tzeltal indicate that blowdown can cause loss of the product, through damage by rats, squirrels and other animals or through decay. The function of hilling up in diminishing damage can be related to better growing of roots in the hill, which may also have more organic material. An alternative explanation has been proposed by Cruz (1999), who has observed that in one locality of the Chiapas highlands the hilling up increases the number of larvae in the roots. This greater density—which does not necessarily increase damage—is probably due to the larvae eating the organic matter added around the plant bases. Villalobos et al. (1997) have demonstrated experimentally that the content of organic material has a negative effect on root-eating activity by white of *Costelytra zelandica*. The foregoing

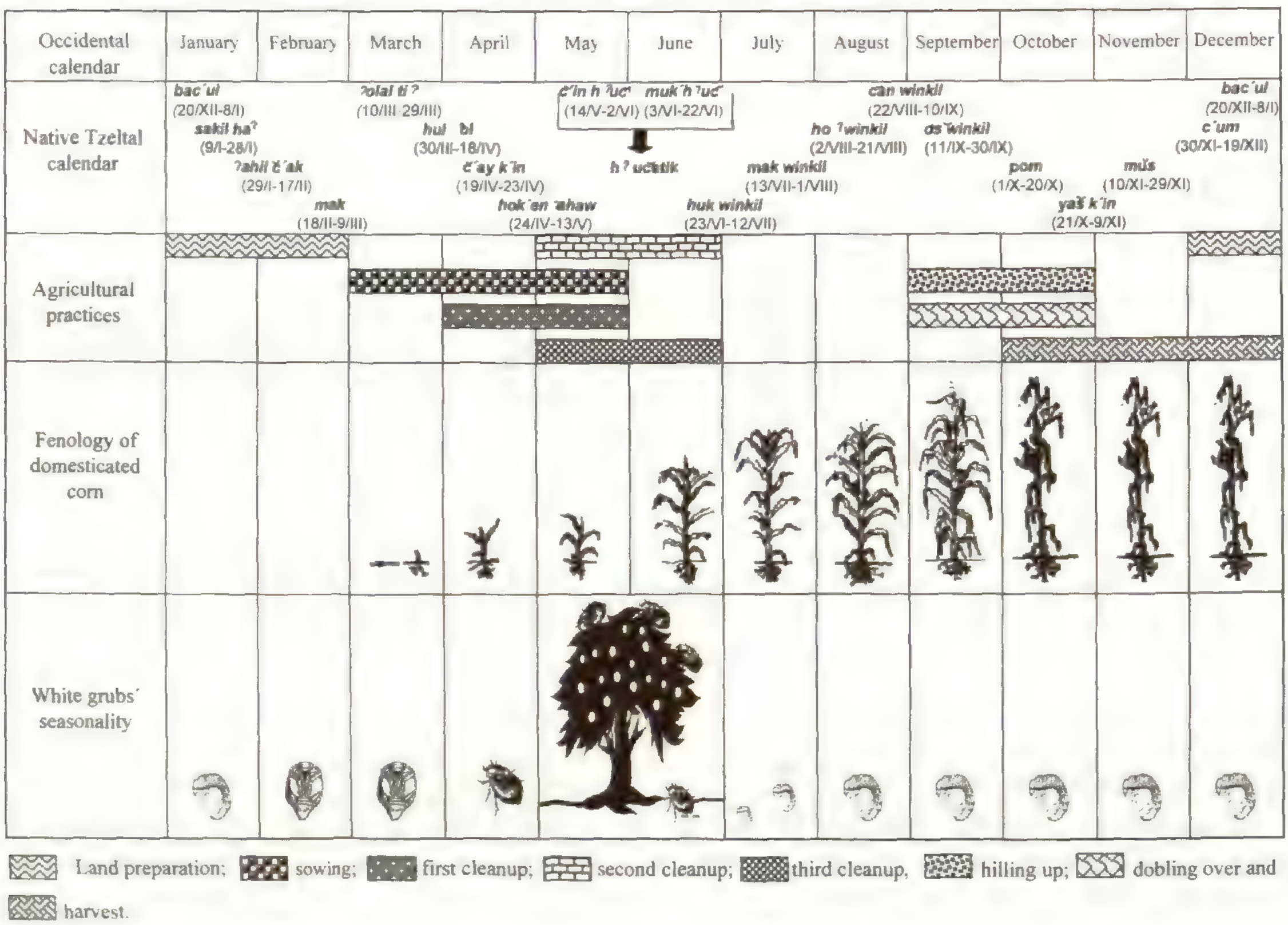

Figure 1. – Agricultural cycle (calendar, practices and fenalogy) of domesticated corn in Balún Canal, *municipio* of Tenejapa, Chiapas and its relationship to white grubs' seasonality.

suggests that hilling up benefits cultivation by adding nutrition to the plant as well as by reducing damage by grubs.

Cleanup. – The farmers carry out 2-3 cleanups of weeds in the fields, to reduce competition of weeds with maize (Table 4). They state that this can reduce infestations of grubs, in that they can kill grubs while weeding. Various authors have suggested that vegetation in the form of pastures (King 1985, 1996) and weeds (Carballo 1996 and references therein) permit the soil to host higher densities of grubs. We assume that this is due to higher survival rates of immature stages, greater chances of oviposition (associated with less compaction of soil), greater availability of food, favorable microclimate, and lower levels of parasitism and predation. However, we think that cleanup of the field also eliminates alternative foods, and centers the grubs' attention on the roots of the cultivated plants.

The Tzeltal and Sustainable Management of Grubs.– Sustainable management of agricultural problems caused by grubs has been defined as a strategy that presents characteristics qualitatively different from integrated pest management, and which is based in ecological, economic and social principles (Villalobos 1995). This author recommends saving traditional agricultural knowledge and practice as one of the principles to achieve this aim. Taking account of this, we advised studying and presenting to the community the effects that could follow from sowing and hilling up in managing the grubs. These activities had not been seen as related to the problem. The information produced by these studies could through light on conditions in which the effect could be better exploited.

The intervention of domestic animals during preparation of the land and cleanup of weeds could be developed to reduce the population of grubs. The renewal of consumption of adults by members of the community could also contribute to regulation of insect populations.

The information possessed by the Tzeltal of Balún Canal about hosts and hours of flying of the adults could be relevant in campaigns of massive collection, as proposed by Cruz et al. (1998). These campaigns could combine with initiatives to use adults of noxious species as food for domestic animals such as fowl and pigs.

The incorporation of organic matter in cultivation, directly via hilling up or through other means (incorporating agricultural wastes and animal dung), could be helpful. Such improvements could improve soil fertility and help reduce damage by grubs, and even help any possible beneficial activities of these insects (Villalobos 1994).

Information on ecology and life cycle of the beneficial and noxious species of Melolonthidae will be fundamental for proposing strategies for a sustainable management of white grubs that would be viable in the community. Ultimately, it will be necessary to evaluate the economic significance of the grub damage in maize cultivation in Balún Canal, to get a clearer diagnostic of the problem and confront it better.

CONCLUSIONS

The principal conclusions of this investigation are:

The ***k'olom*** is a Tzeltal term used for the larvae of a species complex of Melolonthid beetles, of which *Phyllophaga obsoleta* and *Anomal sticticoptera* possibly cause agricultural damage.

Among the Tzeltal, Melolonthids and Scarabaeids are differentiated as adults, but not as larvae.

The Tzeltal of Balún Canal use the terms ***chimol*** or ***umo'*** for the species *Phyllophaga obsoleta, P. sp.* 1 group *Phytalus, P. sp.* 2 group *Anodentata,* and *Anomala sticticoptera.*

The group knows the duration of the life cycle, the larval stage, the adults, and the hour of flight of the latter.

Few know the entire cycle; a large majority is ignorant of the pupal stage, and none are aware of the different larval instars.

The farmers recognize various natural enemies, all vertebrates. They do not know of entomopathogenic microorganisms or invertebrates that participate in natural regulation.

We record for the first time the consumption of adults of *Phyllophaga* by humans in Mexico.

The Tzeltal of Balún Canal have agricultural practices that reduce damage by the grubs. These practices include preparation of land, sowing, and hilling up soil around cornstalk bases.

We should consider as highly valuable the management knowledge, and also non-awareness, found among the farmers.

NOTES

[1] México leads the world in insect-eating, with more than 200 species consumed (Defoliart 1997), so it is not unusual that the group studied here consumes insects. Ramos and Pino (1989) mention that it is surprising that, though scarabs constitute a significant part of the order Insecta, their consumption worldwide is not well known. Some examples of Melolonthids consumed in other parts of the world include: Adults of the genus *Pyronota* are consumed by the Maori of New Zealand (Miller 1974); *Podischnus agenor* is eaten by the Yukpa of northeast Colombia and *Megaceras crassum* by the Tukanoan peoples of southeast Colombia (Defoliar 1997).

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IDENTITY AND CURRENT ETHNOBOTANICAL KNOWLEDGE OF FRANCISCO HERNÁNDEZ'S *"CICIMATIC"*

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ABSTRACT.– Francisco Hernández's *"History of the Plants of New Spain"*, written during the second half of the 16th century, is the main source of historical and ethnobotanical knowledge about the plants that were known during colonial times in Mexico. Despite the importance of this work, the lack of a universal system of nomenclature at that time makes it hard to identify many of the plants encountered in this volume. Currently, more than 2,000 plants remain unidentified and several previous identifications are questionable. Historical investigation of the uses of species belonging to the genus *Ramirezella* (Leguminosae) resulted in an identification proposed for Hernández's *"**Cicimatic**"* as *Ramirezella strobilophora* (Robinson) Rose, a conclusion in accord with Hernández's description, illustration and reported medicinal use. A ***Cicimatic*** was also mentioned in the work of Sahagún (*"General History about the Things of New Spain"*), indicating that it was most likely a valuable plant during colonial times in Mexico. If *Ramirezella strobilophora* is the ***Cicimatic*** of Hernández, the ethnobotanical traditions maintained over more than 400 years may indicate the potential pharmacological value of this species.

Key words: Ramirezella, Leguminosae, Mexico, Colonial times, Medicinal plants

RESUMEN.– La obra de Francisco Hernández *"Historia de las plantas de la Nueva España"*, escrita en la segunda mitad del siglo XVI, es la principal fuente de conocimiento histórico y etnobotánico sobre las plantas que se conocían durante los tiempos de la Colonia en México. A pesar de la importancia de este trabajo, la falta de un sistema de nomenclatura universal en aquel tiempo hace difícil la identificación de algunas de las plantas. Actualmente aún quedan más de 2,000 plantas por identificar, además de varias con dudosas identificaciones, que requieren especial atención de los taxónomos. Una investigación sobre el posible uso de especies en el género *Ramirezella* (Leguminosae) durante los tiempos de la Colonia en México permite proponer una identificación para el *"**Cicimatic**"* de Francisco Hernández como *Ramirezella strobilophora* (Robinson) Rose. Esta conclusión se basa en la descripción botánica, en la ilustración y en uno de los usos medicinales reportados por Hernández. Debido a que un ***Cicimatic*** también se menciona en el trabajo de Sahagún (*"Historia general de las cosas de la Nueva España"*), es posible suponer que se trataba de una planta valiosa durante los tiempos de la Colonia en México. Si *R. strobilophora* corresponde al ***Cicimatic*** de Hernández, las tradiciones etnobotánicas que se han mantenido por mas de 400 años podrían usarse como indicativas de un verdadero valor farmacológico de la especie.

RÉSUMÉ– L'oeuvre de Francisco Hernández *"Histoire des plantes de la Nouvelle Espagne"*, écrite dans le second montié des XVI sénturi, c'est la principale source historique et ethnobotanique de connaissance sour les plantes employer dans les Colonial temps au Mexique. En dépit de l'importance de c'est oeuvre, la manque d'un système de nomenclature universelle dans c'est temps difficulté la connaissance de l'identité des quelque plantes. Actuellement il y a plus que 2,000 plantes par identifier, en plus d'autre avec discutable identité, que nécessite de spéciale atention par les taxonomist. Une recherche sour le possible utilité d'espèces du genre *Ramirezella* (Leguminosae) dans les Colonial temps au Mexique a permis de proposer une identité pour le "***Cicimatic***" de Francisco Hernández comme *Ramirezella strobilophora* (Robinson) Rose. C'est conclusion est appui sur la description botanique, l'illustration et l'utilisation médicinal rapporté par Hernández. Puisque un ***Cicimatic*** est aussi mentionne dans l'oeuvre du Sahagun (*"Histoire générale de las choses de la Nouvelle Espagne"*), il est possible du supposer qu'il éte un plante de valeur dans les Colonial temps au Mexique. Si *R. strobilophora* correspondre avec le ***Cicimatic*** d'Hernández, les traditions ethnobotaniques qu'il s'aveaux garder pour plus que 400 année pouvoir indiquer une vrai valeur médicinale de c'est espèce.

INTRODUCTION

Francisco Hernández's *History of the Plants of New Spain* is the main source of historical and ethnobotanical knowledge about the plants that were known during early colonial times in Mexico. Hernández's work provides botanical descriptions for 3076 plants (Flores and Valdés 1979), together with their common names, uses and, in some cases, illustrations. The significance of Hernández's work is reflected in the various attempts to publish his entire contribution. Portions of it were published in four versions: in Mexico by Ximénez (1615); in Italy (1651); in Madrid (1790), and again in Mexico by the Instituto de Biología, Universidad Nacional Autonoma de México (1942-1946). The only complete version of Hernández's work was published in seven volumes by the Universidad Nacional Autonoma de México between 1959 and 1984 as the result of a multidisciplinary effort that involved the participation of botanists, zoologists, linguists, geographers, and historians.

Despite the unquestionable merit of Hernández's work, botanical writings of the era lacked a universal nomenclatural system. The use of common names that can refer to more than one species, be modified, or disappear with time, confounds the ability of modern workers to determine the identity of the species reported by Hernández. Many researchers have provided significant contributions to the better understanding of the *History of the Plants of New Spain* (*e.g.*, Sessé and Mociño 1887 a and b; Ramírez 1893; Altamirano 1896; Urbina 1897; Standley 1920-26; Batalla *et al.* 1942-1943; Miranda *et al.* 1946). However, the sheer volume of information and the more than 400 years that have passed since its creation still leave much interesting ethnobotanical information to be rescued.

To obtain a better understanding of the information for the more than three thousand plants mentioned by Hernández, it is essential to know their taxonomic identity. Only about half of the plants mentioned by Hernández have been stud-

ied (1,544). Based on the short but accurate botanical data provided by Hernández as well as the occasional figures, identifications have been proposed for 98 names to the level of family, 249 to genera, and 667 to species (Flores and Valdés 1979). These names were compiled by Valdés and Flores (1984) in the seventh volume of *The Complete Work of Francisco Hernández*. The remaining 530 of the studied names were not identified. The more than 2,062 names for which either no botanical comment has been given (Flores and Valdés 1979), or whose taxonomic identity is doubtful, stress the need for the participation of taxonomic specialists who could interpret Hernández's work.

In revising the genus *Ramirezella* (Leguminosae, Papilionoideae), it was noted that one species, *R. strobilophora* (Robinson) Rose, has many common names and traditional medicinal uses in Mexico (Ochoterena-Booth 1991). Distributed primarily along the Pacific slope of the Sierra Madre Occidental, from southern Sonora and Chihuahua to Nicaragua, *R. strobilophora* is known by 11 common names: ***Nowá*** (Chihuahua); ***Cuahuexutl, Ejote de Monte*** or ***Dichi-kuu*** (Guerrero); ***Frijolillo*** (Guerrero, Morelos and Oaxaca); ***Periquito Azul Grande*** (Morelos); ***Flor de Paloma*** or ***Ie-paloma, Gallinita*** (Oaxaca); ***Choreque*** (Chiapas) and ***Choncho*** (El Salvador). The root of *R. strobilophora* is used by indigenous groups in northwestern Mexico as a catalyst in the fermentation of *Agave* to prepare the beverage that the Warihios call ***batari*** (H. S. Gentry 2404, F, MEXU, US). The Rarámuri (Taraumaras) use it for the same purpose during the fermentation of maize to produce ***tesgüino*** (R. Bye 2847, COLO). In Oaxaca (Mexico) the bark of the liana is ground with water to treat ***fuegos*** (M. Sousa 7069 *et al.*, MEXU), a kind of ulcer of the mouth (cold sores). In addition to this medicinal use, the boiled or toasted fruits are eaten locally (M. Sousa 7069 *et al.*, MEXU; J. L. Viveros and A. Casas 332, MEXU). The present-day uses of *Ramirezella strobilophora*, as well as the great number of common names, motivated bibliographic research on the possible uses of this species during colonial times.

METHODOLOGY

Due to the morphological similarity between the genus *Ramirezella* and *Phaseolus* (the common bean), descriptions and illustrations of Hernández that refer to beans (***frijoles***) were compared to species of *Ramirezella*. These were located using the indices of the *History of the Plants of New Spain* (Hernández 1959). All descriptions that clearly did not correspond to *Ramirezella* were ruled out. The works of de la Cruz (1964, first edition 1552) and Sahagún (1969, first edition 1590) were then consulted using Hernández's names in addition to beans (***frijoles***). The current ethnobotanical information of *Ramirezella strobilophora* was obtained from the notes on the labels of herbarium specimens.

RESULTS

Great resemblance was found between *Ramirezella strobilophora* and the illustration of the "***Cicimatic***" (Fig. 1A) from the *History of the Plants of New Spain* (Hernández 1959). The similarity of the illustration was corroborated by the de-

scription of the "***CICIMATIC*** *or a plant similar to the* ***címatl***" (Book 1, Chap. LVII), which can be translated as follows:

> About the ***CICIMATIC*** or a plant similar to the ***címatl***, The root is like that of the turnip and fibrous; twining red stems are borne from it with three-foliolated leaves that are heart shaped and similar to those of the other beans, of which it is a species, and medium size legumes which are produced by purple flowers in cluster like groups. It has a cold and astringent temperament. The root, when crushed and sprinkled, cures ulcers because it cleans them and favors healing; therefore many people call it ***palancapatli***, which means medicine for ulcers. It relieves in an admirable manner the inflamed sick eyes, removes clouds and fleshy excrescence, stops discharges of the abdomen, cures cough and makes parturient [women in labor] stronger. The cooked root is good against dysentery. It grows in temperate or warm regions like the Mexican one.

The same name (***Cicimatic***) was found in the *General History about the Things of New Spain* from Sahagún (1969: Volume III, Book 11, Chap. 7, No. 232, Pg. 322) and the description also could be assigned to *Ramirezella*.

FIGURE 1A and B.– "***Cicimatic***" reproduced from Hernández (1959).

DISCUSSION

About the name.– Santamaría (1942 and 1974) reported that *"Senecio vulneraris"* (presumably *Senecio vulneraria* DC) is known as ***"Cicimate,"*** a name derived from ***"Cimatl."*** Nevertheless, the description and illustration of Hernández do not correspond to species of *Senecio* or any other Composite and therefore it is easy to discard this as a potential identification for Hernández's ***Cicimatic***. Many of the common names reported by Hernández are apparently not applied any more. This could be due to the lack of current ethnobotanical information about Mexican plants, or it could be that the names were lost after the more than 400 years that have passed since the work was written. The second case represents a likely possibility for the ***Cicimatic*** since the name itself referred to another plant, as can be seen in the Hernández's translation: *"a plant similar to the* ***Címatl***. Nonetheless, the existence of another species known with that common name (*Senecio vulneraria* DC) allow us to still consider the first alternative. None of the 11 common names by which *Ramirezella strobilophora* is currently known is linguistically related to it. According to Martínez (1979), the name ***Cimatl*** refers to *Phaseolus coccineus* L., but this reference could have been obtained from a proposed identification of Hernández's ***Cimatl***. According to Paso and Troncoso (1988) the word ***Cimatl*** "was applied to roots which are almost always succulent, commonly perpendicular, and sometimes pivoting, whether they were edible or not... **címatl** was equivalent to stump or underground axis."

About the proposed identification.– Urbina (1897) proposed that the description and characteristics of the figure correspond with *Canavalia villosa* Benth. More recently, Batalla *et al.* (1942-43) took up Urbina's identification (Valdés and Flores 1984).

While some of the characteristics of the genus *Canavalia* agree with Hernández's illustration, others do not. The stipules in this genus are small and deciduous, contrasting with the illustration of Hernández (Fig. 1A), which shows very conspicuous stipules. On the other hand, the inflorescence of *Canavalia* is a cluster in which the lower, more mature flowers are bigger than the upper ones, giving to it a conic aspect similar to Hernández's illustration. Although the flowers have the color mentioned by Hernández, the morphology is different from the flowers of beans (*Phaseolus*) and can be easily distinguished. The fruits are comparatively larger than the legume of beans and have a rib along the side, which lends them a distinctive and characteristic aspect hard to confuse with a bean.

Besides the lack of conclusive morphological evidence to interpret Hernández's ***Cicimatic*** as a *Canavalia,* there is no current common name known for any species in this genus that can be connected with ***Cicimatic*** or ***Palancapatli***. Nor is there ethnobotanical support for this identification. Although the fruit of *Canavalia* is eaten in some regions (*e.g.* Guerrero, Mexico), there is no information about any medicinal use. In summary, although there are some similarities between the illustration and *Canavalia,* this identification is not supported.

About the description.– Several species of the genus *Ramirezella* were described or considered at some point as *Phaseolus* before that genus was convincingly delimited. This reflects the great morphological similarity of both genera. The description

of the ***Cicimatic*** provided by Hernández is consistent with the characteristics of the genus *Ramirezella*. Although the vegetative characteristics in most of the Phaseolinae species are very similar, the description of the root resembling "the one of the turnip and fibrous" fits the root morphology of the genus *Ramirezella* (Fig. 2C). The fruits of *R. strobilophora* (Fig. 2B) are bigger than those of wild beans (*Phaseolus*), reaching sizes between 11.5 and 17 cm. Therefore, they can be categorized as "medium size." The flowers are grouped in a kind of inflorescence that is known as a pseudocluster (Fig. 2A). The color of the flowers of *R. strobilophora* varies from white to violet, so that the tonality corresponds to that mentioned by Hernández.

About the uses.— Among the long list of medicinal uses reported by Hernández for the "***Cicimatic,***" there is one in common with *Ramirezella*. Hernández's text describes the capacity of ***Cicimatic*** to cure ulcers, a feature reflected in Hernandez's translation of a second common name: "***palancapatli*** or medicine for ulcers." As mentioned previously, *Ramirezella strobilophora* is used in Oaxaca to treat cold sores, which can be considered a kind of ulcer.

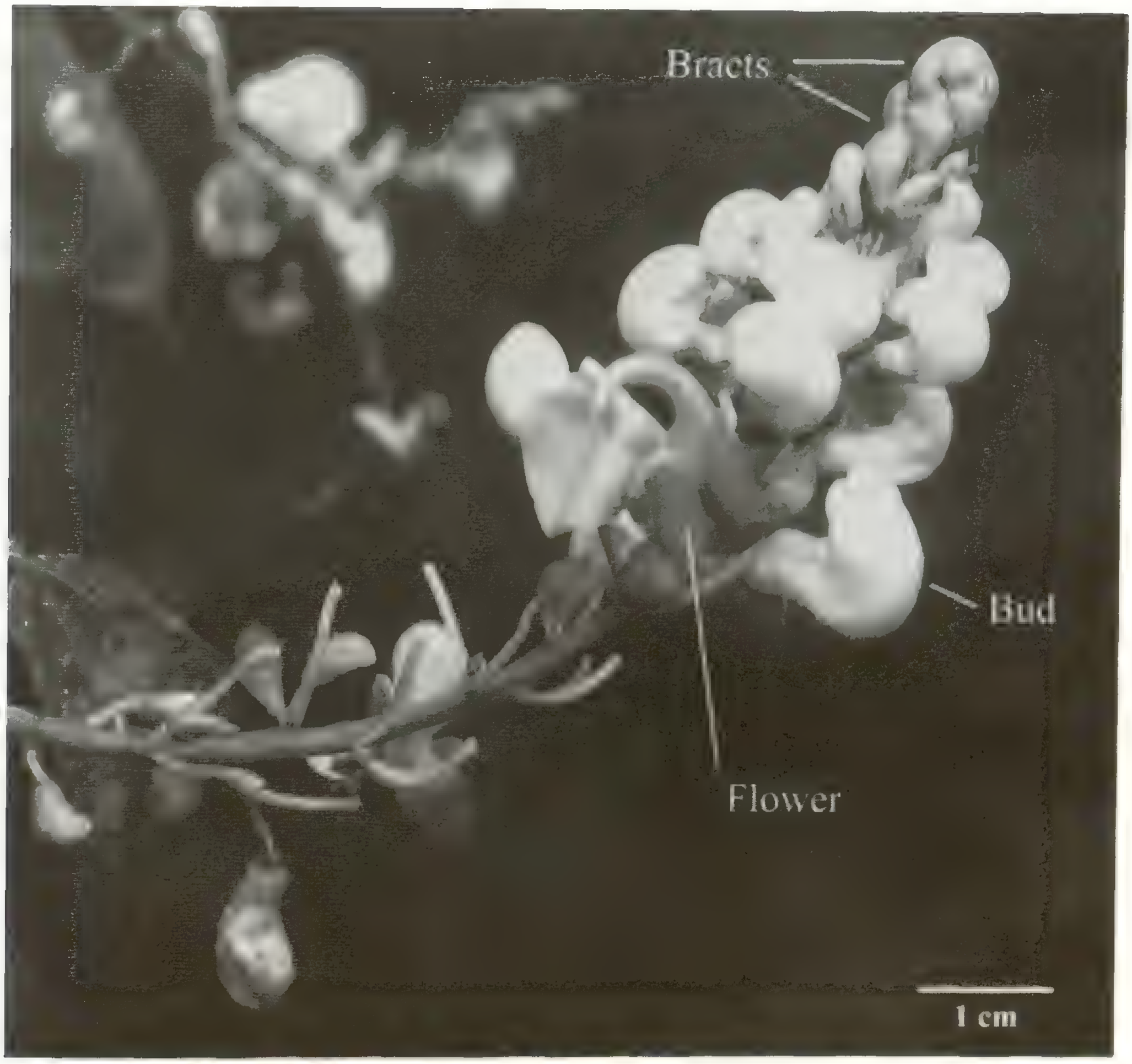
The properties of the root of ***Cicimatic*** were emphasized by Hernández. It is interesting to note that the same part of the plant is currently used to elaborate fermented beverages. Gentry (1942) pointed out this employment of the root by the Warihios, but he unfortunately misidentified his collection number 2404, giving to it the name *Phaseolus caracalla* L. instead of *Ramirezella strobilophora*. This error caused confusion in the subsequent use of the information, for in a later work, Gentry (1963) wrote:

> The chopped pieces [of Agave's stems] are put into large ollas [pots] of water, and as a catalyzer the root of a vine (***nawo***) (*Phaseolus caracalla* L.) is put in, which they say causes the water to 'boil'. After a day or so the bubbling stops and the batari is ripe for drinking. The older the brew becomes after this point, the weaker it grows and they speak of it depreciatively as 'pasado' [over-fermented]. If plenty is drunk, inebriation ensues. The drink has a sour astringent flavor.

In the above passage, Gentry did not cite any reference specimens, but it is clear that the information came from his 1942 publication because of the coincident use, scientific name and common name, the latter, by the way, with ***nowá*** appearing as ***nawo***.

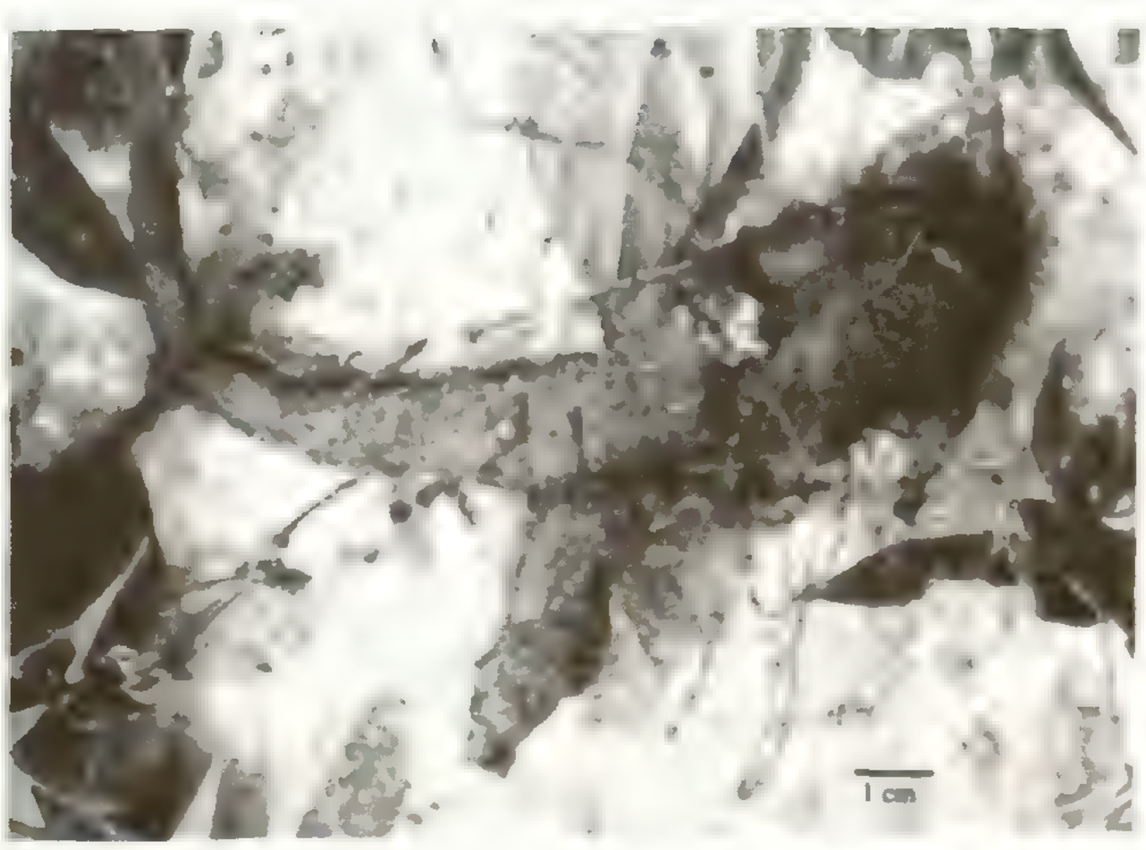
The fact that *Ramirezella*'s root affects the activity of bacteria and fungi may reflect the existence of some interesting compounds, as has been reported for *Phaseolus* (Litzinger 1983). Litzinger mentioned the presence of isoflavonoids, steroids, oxidative enzymes, non-proteic amino acids and indol alkaloids, which, according to Lappe and Ulloa (1989) take part in the catalytic conversion of the substrate during the elaboration of fermented beverages. Litzinger (1983) suggested that these substances could have medicinal applications or help in the treatment of intoxication.

Two interesting points regarding traditional uses of plants through history rise in this case. The first one is related to the loss of uses, the second to the acqui-



A.

B.



C.

FIGURE 2.– Morphological characteristics of *Ramirezella*: (A) inflorescence of *R. strobilophora* (Robinson) Rose; (B) fruits (legumes) of *R. strobilophora*; (C) root of *R. nitida* Piper.

sition of uses. Are there more medicinal uses for *Ramirezella* that we do not know? If not, why did the other medicinal uses reported by Hernández get lost? On the other hand, were the roots of *Ramirezella* always used in the preparation of fermented drinks and Hernández did not capture this information? If not, when and how was this used acquired? More ethnobotanical research is needed in order to try to understand these questions.

About the illustrations.– As can be seen in the illustrations of the ***Cicimatic*** reproduced from Hernández's work (Fig. 1 A and B), there are differences between the two plants illustrated. The plant of figure 1A has a shorter root than that of Figure 1B and the detail of the flower (bottom right Fig. 1B) does not correspond to one of the Phaseolinae group because of its radial symmetry. The plant of figure 1A can be identified as a kind of bean or a related group because it shows trifoliolated leaves with stipules and a legume similar to a green bean (bottom right).

Comparing the illustrations with the descriptions of Hernández, figure 1B can be best assigned to ***AYECOCIMATL,*** which has the descriptive subtitle "a herb similar to the ***Címatl***" (Book 1, Chap. LV). The fact that the name ***Ayecocimatl*** also alludes to the ***Cimatl*** could be the cause of a mistake in the inclusion of this figure under the ***Cicimatic***. In the description of the ***Ayecocimatl,*** Hernández says that it has "...flowers at the end of the branches, scarlet and radiated as a star...," just as it is represented in the detail of figure 1B. To assign this figure to the ***Ayecocimatl,*** which from the description was identified as *Phaseolus coccineus* L., opens the need for its reinterpretation, which in fact requires further study.

Figure 1A, on the other hand, corresponds to the description of the ***Cicimatic*** and *Ramirezella,* especially because of the inflorescences, which appears to be a many-flowered cluster, and has the general aspect of this genus (Fig. 2A). In the drawing of the inflorescences it is possible to distinguish structures that can be interpreted as buds protected by bracts (Fig. 1A). Relatively large and persistent bracts are characteristic of the genus *Ramirezella*. The fruit and vegetative characteristics can also be associated with this genus (Fig. 2 B and C).

About other sources of the XVI century.– In the *de la Cruz codex* (1964), the first written work we know that refers to medicinal Mexican plants (originally published in 1552), also known as Badiano codex, there is no plant that can be related with the ***Cicimatic*** (Valdés *et al.*1992).

In the *General History about the Things of New Spain* (Volume III, Book 11, Chap. 7, No. 232, Pag. 322) Sahagún (1969, first published in 1590) wrote:

> There is another medicinal herb called ***cicimatic***; it is a vine, with many very green leaves and wide growing in groups of three; it is like the beans; the green parts are not useful at all; the root has no flavor and is hard as a trunk, almost the size of the head of a person and large as an elbow; it has a thick bark, black outside and with thick red spots inside. Grounded, it is good for people with sick eyes that have a fleshy excrescence called ***ixnocapachiui***; the ground-up root is covered with a cloth and squeezed over the eyes, after that, the fleshiness that covered the eyes is gone; it grows in all the mountains.

Later in the same work (Volume III, Book 10, Chap. 28, No. 9, Pag. 170), Sahagún wrote:

> Against the sores outside the ears there are these remedies: take the leaf of ***coyolxóchitl***, grind it and mix it with ***ocótzotl*** and put it over the sore, or grind it and mix it with the ***ajíya*** already mentioned and apply it on the sore, or take the herb called ***cicimatic*** in the [native] language, mix it with egg whites and apply it on the sore, or use all the other herbs that can be used to treat the rotten sores like the herb called ***chipilli*** and the stone of the avocado.

The woody and hard root of *Ramirezella* can reach up to 70 cm in length. A red resin is present in both the stem and the root (Ochoterena-Booth 1991), characteristics that coincide with Sahagún's description. The names mentioned by Sahagún are the same as Hernández, which suggests that it was an important plant during prehispanic and colonial times in Mexico. Estrada Lugo (1989), probably following Urbina's identification, suggested that the Sahagún's ***Cicimatic*** corresponds to *Canavalia* sp. The same arguments made in favor of the *Ramirezella* identification can be also applied here.

CONCLUSIONS

Due to the inherent problems interpreting a treatment greater than 400 years old, it would be incorrect to reject categorically any alternative identification for Hernández's plants. However, Hernández's description of ***Cicimatic*** as "...similar to those of the other beans, of which it is a species;" the evidence of stipules in the illustration (Fig. 1A); the characteristics of the inflorescence in the drawing, here interpreted as bracts (Figs. 1A and 2A), the kind of fruit (Figs. 1A and 2B); the uses for the plant, and the description of Sahagún, more probably correspond with those of *Ramirezella*. If this is true, considering the distribution and morphological characteristics of its species, it appears to be *R. strobilophora*. With this new interpretation, interesting alternatives emerge for future research related with the ethnobotany and potential pharmacological value of the genus *Ramirezella*. This kind of research could reinforce the proposed identification for the ***Cicimatic*** and at the same time allow a better use of Mexican natural resources.

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Gentry's Rio Mayo Plants: The Tropical Deciduous Forest & Environs of Northwest Mexico. Paul Martin, David Yetman, Mark Fishbein, Phil Jenkins, Thomas Van Devender, and Rebecca Wilson, eds. The University of Arizona Press, Tucson. xvi and 558 pp., maps, diags., photos, notes, refs., and index. $75.00 cloth (ISBN 0-8165-1726-6).

Howard Scott Gentry is finally getting his due. This volume is a completely updated, re-edited version of Gentry's original study of the Rio Mayo, in Sonora, Mexico. Here, in the moist canyons of the Rio Mayo, biologists continue to encounter the juncture of Neo-Tropical and true Sonoran Desert plant species. The original 1942 release of *Rio Mayo Plants* was to be the first of many volumes produced by one of the better field biologists of the century. Gentry did not consider himself to be a true botanist, and yet his contributions have endured, and his volume on the Agaves of North America is still the most comprehensive treatise on the subject of these succulents.

This new version is a beautifully produced, almost intimidating, compendium of new information on the region and its flora. To be sure, portions of Gentry's original prose are present, but only amount to about 40 pages in the new version. The editors of this tome have organized the volume into four sections. Part 1 consists of an overview of the Rio Mayo region, extant literature, and the contemporary vegetation patterns. A list of localities cited in the study follows in Part 2, and part 3 is a portion of Gentry's original work in describing the Rio Mayo. The bulk of this book is found in Part 4, which is a massive and useful annotated list of the Rio Mayo's vascular plants. The editors carefully organized this information, and were cautious with their taxonomic nomenclature; the region begs for further botanical and systematic work.

It is impossible to review a taxonomic list of new plant collections this vast. The contributors to the volume include 27 botanists and biologists, not including the large numbers of collectors involved in the revision of *Rio Mayo Plants*. Each individual plant citation provides the scientific name, common names in Spanish, as well as indigenous languages of the region (Guarijio, Mayo, and Pima). They also include habitat descriptions, the site of collection, and verbal descriptions of the plants as well as their past and current uses by locals. The first three sections of the book contain photos, tables, as well as illustrations completed by Paul Mirocha. Two maps are provided with the volume: one is a large foldout of the Rio Mayo region, while the smaller encapsulates the vegetation of the region. The annotated list, however, lacks any illustrations. The new volume is rather useless as a key in the field, yet the amount of information contained in the new list of plants justifies the cost of this volume, for true enthusiasts at least. The number of species described, or rather taxa, has more than doubled since the original volume appeared. In addition, the contributors explicate the Rio Mayo's changing biogeography, and how current patterns of land-use are changing the vegetation composition of this area.

The writing is clear, pithy, and fairly uniform. This is an uncommonly good trait for an edited volume with a large number of contributors. The only flaw in the production of this updated Rio Mayo Plants volume is that the press adver-

tises the inclusion of a large color map: my copy was black and white. Undergraduates, graduate students, and professionals interested in biogeography, ethnobotany, and arid lands ecology will want (to use) this encyclopedic work. Most libraries, especially those located in the Southwestern U.S., might find it useful to buy two copies of this volume. Paul Martin and friends have given us a true gem, although as they note themselves, the mountains of southern Sonora beckon for more botanical work. Surely more treasures of the Sierra Madre remain to be discovered. Had Gentry survived to see the release of this work, he would be pleased.

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MANAGEMENT OF TREES USED IN *MURSIK* (FERMENTED MILK) PRODUCTION IN TRANS-NZOIA DISTRICT, KENYA

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ABSTRACT.– Milk treatment using trees is an age-old practice of both sedentary and nomadic pastoral communities in Kenya. Due to economic, political and environmental pressures, many pastoralists have become settled farmers and turned to crop cultivation as their main means of survival. However, they have continued to keep some cows and to treat their milk using traditional practices, incorporating the desired tree species into their farming system. This paper presents information as to how species are identified and selected, how the trees are managed, management problems associated with the trees, and how farmers evaluate the results of continuing experimentation with trees used for ***mursik*** production.

Key words: Fermented milk, ***mursik***, pastoralism, farming, Kenya

RESUMEN.–Tratamiento de leche usando arboles es una antigua practica de comunidades pastoriles sedentario y nómadas en Kenya. Por la influencia económico, política y ambiental, muchos ganaderos se hacen agricultores y se mantienen con las cultivación de comida cómo su superviviente. Además, ellos siguen manteniendo vacas y tratando la leche con prácticos tradicionales, incorporando los arboles necesarios en su sistema de agricultura. Este papel va

presentar información en cómo los especies se identifican y escojan, cómo los arboles se mantienen, problemas con los arboles, y como los granjeros evalúan los resultas de los experimentos continuos con los arboles en el uso del producción ***mursik***.

RESUME.– Le traitement du lait à partir de certains arbres pour la production de *mursik* est une pratique ancienne des communautés pastorales à la fois sédentaires et nomadiques au Kenya. A cause des pressions économiques, politiques et écologiques au cours des années, beaucoup de pastoralists sont devenus des cultivateurs comme moyen principal de survivre. Néanmoins, ils continuent d'élever des vaches laitières et d'utiliser leurs pratiques traditionnelles de traitement du lait en incorporant des espèces d'arbres utiliser pour ce but dans leurs champs. Cet article présentera des informations sur l'identification et la sélection des espèces, la gestion de ces arbres, les problèmes de gestion rencontrées, et les méthodes employées par les éleveurs pour évaluer les résultats des leurs expérimentations continuelles avec des espèces d'arbres utilisées pour la production de ***mursik***.

INTRODUCTION

Tree diversity is generally low in farming systems compared to natural ecosystems such as forests. Even so, forest and tree resources provide many benefits and form an important part of the rural household economy. Trees are used in various ways for economic, social and cultural purposes. To a large extent, rural people themselves determine the tree species that grow on their farms and influence each other in terms of what agroforestry practices to adopt or to reject. Extensive discussions with farmers in Trans-Nzoia District, Kenya, revealed that every tree growing on farmers' land has a role to play in the household economy. However, as some common and widely used tree species are facing extinction in both their natural and human-modified habitats due to population pressures and increasing demand for cultivation land, efforts should be made to document the uses of tree resources so that good cultivation and conservation practices can be developed.

Such is the case with the tree species[1] used for the preservation of milk for the production of ***mursik***, a traditional technology developed and widely used by various pastoral groups in Kenya. ***Mursik*** is the Kalenjin term for fermented milk, but the term is recognized and used by all ethnic groups in the research area. To date, little has been written about traditional milk preservation practices in Kenya. Articles found in most cases provide only very brief descriptions of the technology. Even the series of district socio-cultural profiles published in the mid-1980s devote only a few paragraphs to describing the technology (e.g., Were and Wanjala 1986; Wanjala and Nyamwaya 1986; and Were and Olenja 1986). Other articles summarize the process of sour or fermented milk production as an introduction to their main topic, the microbiological analysis of fermented milk products (e.g., Miyamoto *et al.* 1985; Ashenafi 1993; Feresu 1992; Isono *et al.* 1994; Kassaye *et al.* 1991; Mutukumira 1995; Mutukumira *et al.* 1995; and Nakamura *et al.* 1999). Shalo (1987) provides a generalized description of the pastoral methods of handling and

preserving milk practiced in Kenya, paying particular attention to the initiation and preparation of the milk storage gourds. The technology, however, is not restricted to Kenya, but is widely used in other Africa countries as well, for example the Sudan (Abdelgadir *et al.* 1998), Zimbabwe (Feresu 1992; Mutukumira *et al.* 1995; Mutukumira 1995), Tanzania (Isono *et al.* 1994) and Ethiopia (Ashenafi 1994; Kassaye *et al.* 1991).

More detailed descriptions of the process to produce ***iria ri matii***, a fermented milk produced by the Meru, is provided by Kimonye and Robinson (1991), while the production of ***mursik*** is described by an anonymous author in Food Chain (Anon. 1994). The Meru people use charcoal from *Olea europaea* L. ssp *africana* (Mill.) P.Green to coat the inside of storage gourds; the attractive flavour/aroma of wood smoke is an essential characteristic of the product. The authors also describe the microbiology of the process involved. Wanjala and Nyamwaya (1986) reported about the production of ***murskik*** (sour milk) among the Tugen in Baringo District using charcoal obtained from *Euclea divinorum* Hiern. The purpose of doing so, according to these authors, is threefold: (1) it preserves the milk for a longer period; (2) sour milk is a strong and healthy meal in itself; and (3) it gives the milk colour and scent. The charcoal crushed into the gourd keeps it from wearing out fast, and it also erases the natural smell of a gourd when milk is drunk from it. Similar procedures are used by the Pokot and the Ilchamas (Wanjala and Nyamwaya 1986), but no mention is made of the species used for the charcoal to coat the milk storage gourds.

The Maasai in Kajiado District use *Olea europaea* L. for the treatment of their gourds for the preparation of ***osaroi*** (sour milk), which is believed to assist milk in fermentation and "gives it a pleasant flavour enjoyed by the Maasai people" (Were and Wanjala 1986). From the description given by Were and Wanjala (1986), it is unclear whether the Maasai coat the gourds with charcoal as is done by the Tugen, Pokot and Ilchamas, or whether the gourds are only smoked with a burning piece of wood. Miyamoto *et al.* 1985 reported on the production of ***maziwa lala*** (Kiswahili for sour milk) by the Maasai in Nakuru, Narok and Kajiado Districts of the Rift Valley Province in Kenya. In a brief description on the preparation methods of ***maziwa lala***, Miyamoto *et al.* state that a gourd is washed with hot water and rubbed with the burnt end of some chopped sticks from a tree known as ***mutamayio*** (this tree could not be identified in Beentje (1994) or in other sources). This is done for both flavouring and pasteurizing. An anonymous author writing in the journal Food Chain (1994) about milk preservation by the Kalenjin in Baringo District provided a good description of the process of milk preservation using charcoal, as well as an explanation of how the technique works to preserve the milk. Like the other studies, the author identified only one tree used for this purpose (***ite)***, but did not provide a scientific name of this species. ***Ite*** could refer to *Acacia mellifera* which is spelled as ***Iti*** in Samburu and ***Oete*** or ***Eite*** in Maa according to International Centre for Research in Agroforestry (ICRAF)(1992), or ***Oiti*** according to Beentje (1994). According to Ronoh (1987), the methods used to preserve milk by the Maasai, Kalenjins, Boranas, Turkanas, Pokot and Somalis are such that milk can be kept as long as three months.

Riley and Brokensha (1988) briefly described milk preservation practices among

the Mbeere, who live on the semi-arid plains south of Mt. Kenya. The Mbeere use smoke to sterilize the gourds used for milk storage, contrary to farmers in the above mentioned studies who use charcoal. Nevertheless, the charcoal may still smoke when crushed in the gourds, thus indirectly providing this sterilizing service as reported in the article "***Mursik*** - Fermented milk in Kenya" (Anon.,1994). Several tree species are used by the Mbeere to smoke their gourds, but they are different from those used by farmers in the other studies cited above, reflecting the different ecological and biogeographic conditions in each area. Kassaye *et al.* (1991) also reported on the use of smoke to prepare the storage gourds for the preparation of ***ititu*** (or concentrated, fermented milk) by pastoralists in Southern Ethiopia. Pastoralists there use wood from *Acacia nilotica* (L.) Willd. ex Delile to smoke the gourds. Another study from Ethiopia (Ashenafi 1994) also mentioned the smoking of fermenting vessels with *Acacia nilotica* wood by pastoralists in rural areas. In the highlands, however, smoking of containers with olive wood is more common according to Ashenafi (1994). Smoking of milk gourds is also used by the Turkana as reported by Galvin (1985).

The above studies indicate that the use of charcoal and smoke from selected tree species is widespread among pastoral people in East Africa. However, the authors (with the exception of Riley and Brokensha 1988) make it appear is if each ethnic group only uses one specific species for the treatment of their milk, which may or may not be the case. In addition, none of these studies report on the tree species themselves, such as where pastoralists obtain the wood, whether the trees used in the process are actively planted and managed, or the specific problems farmers encounter using the technology (in particular related to the trees employed for the process) and ways they have tried to solve them. This article will address some of these gaps. It is based on a study of milk treatment by farmers in Trans Nzoia District, Kenya. Our intention is not to provide a detailed description of the milk preservation process as such, but to provide more information about the trees associated with the technology and their management.

OBJECTIVES

The integration of woody species with crops and animals is an age-old practice of people throughout the world. The formal study of what is now termed agroforestry, however, started only about 20 years ago. Despite heavy investment in research and extension in these two decades, agroforestry efforts have met mixed success, largely because researchers and extensionists have not paid sufficient attention (if any at all) to farmers' experiences with systems designed and developed through their own efforts (den Biggelaar 1996a). The realization that, independently of formal research and extension, farmers and communities in every country carry out spontaneous experimentation on tree cultivation and management, and share findings with others, led to a major initiative by the Forest, Tree and People Programme (FTPP) to document these informal research and extension practices. A case study format was chosen by FTPP as the best way to study farmers' experimental and information sharing practices and processes, enabling outsiders to understand their underlying rules and logic in different regions around the world.

The objectives of the case studies were two-fold:

1. To document how selected farmers organize experiments and disseminate improved forest and tree management practices. The case studies were geared less at describing specific improved practices, but more at developing an understanding of the "why" and "how" aspects behind the practices.
2. To define the current and potential role (if any) for outside institutions (e.g., NGOs, research, extension, donor-funded projects, universities) to support farmers in the above endeavors.

The study presented in this paper was one of four case studies undertaken in East Africa as part of the global FTPP initiative, and was guided by the above objectives. The specific topic was chosen after preliminary discussions with key informants in Trans-Nzoia District. The informants suggested milk treatment for this study, as it was an innovation developed by pastoral people themselves that is culturally important, widely spread across different ethnic communities in the research area, and still much in use to this day. For example, Kalenjin-speaking people (Kipsigis, Nandi and Tugen among others) believe that milk cannot be consumed fresh, but must undergo treatment before consumption. During the initial visit to the area, farmers mentioned several problems that could impede the future use and further development of the technology. Chief among these problems are the dwindling supplies of certain favoured tree species used for milk treatment in spite of having incorporated some of these species into the farming systems. However, a more thorough understanding of the technology and the exact nature of the problems would be necessary to determine how outside institutions could help farmers maintain and develop the technology further.

This study investigated the nature of the milk treatment procedures used by farmers in Trans Nzoia District, origins of the technology, and the selection, management, and incorporation of trees used for this purpose within the farming system. We conclude the paper by identifying a number of areas in which research and development could be of assistance to improve and extend the use of this technology as a viable alternative to modern, expansive, capital-intensive milk processing plants.

METHODOLOGY

Data collection and analysis.– The study was carried out in a three months period between August and October 1996, and consisted of three stages. Stage one involved a reconnaissance tour of the District by the researchers from Moi University together with the area agricultural extension officer and representatives of the Kaisagat Environmental Conservation Youth Group to identify the topic of the case study. During the tour, interviews were conducted with key informants (individual farmers and farmer groups). The majority of participating farmers were traditional pastoralists who had settled in the District and turned to farming as a survival strategy. They had a highly developed traditional knowledge on the use of tree resources for fodder, medicine (for livestock and human beings), food and milk preservation. Traditionally, these communities did not plant trees since natu-

ral regeneration ensured a sufficient supply of trees for various uses. The demand for land for settlement and crop production, however, reduced forest cover and tree species diversity. Nowadays, farmers are actively planting and conserving tree species, especially those which address their cultural and economic needs such as species suitable for milk treatment.

Stage two involved collection of data from individual households. This stage involved direct observation of the milk preservation procedures used by farmers, and the use of structured interview schedules and informal interviews about the process, tree species used and their management, and problems and constraints encountered. A multistage sampling method from division to location was adopted to ensure that all ethnic groups in the two locations were included in the sample. Within the district, two divisions (Cherangani and Kwanza) were chosen randomly; in turn, one location was chosen at random in each of the two divisions. In each location, households of different ethnic groups were chosen based on their perceived knowledge and expertise of milk treatment based on information from key informants. Since women are the custodians of indigenous knowledge in the area of food preservation, the sampling procedure was directed towards them. However, both the head of the household and his spouse (if applicable) were interviewed. A total of 60 farmers (36 from Cherangani and 24 from Kwanza) were interviewed. Semi-structured interview schedules were used to guide the interviews to assure that similar information was collected from each household. Nevertheless, based on the answers of respondents, additional questions were posed to seek clarifications and additional information. Questions in these interviews included descriptions of the technology (often including a showing of milk gourds, utensils, prepared branches) to learn how it is milk treatment is done; perceptions of how and why the treatment is effective in preserving milk; choice of species used and their advantages and disadvantages; changes in species used from the past and/or from respondents' area of origin, and the reasons for these changes; location(s) where farmers collect species used in milk treatment; and problems and constraints encountered with the technology in general and the desired species (esp. regarding their multiplication nd management) in particular. A standard form designed by the researchers was used to collect information on each species used and cultivated for the purpose of milk preservation.

Stage three consisted of two community workshops in which the results of the surveys, observations and informal interviews were presented to the community for verification, discussion and further explanation where necessary. Small group discussions using a list of questions were used to further explore key issues related to milk treatment (past, present and future).

Species identification.-In general, species were identified through their vernacular names used by the different ethnic groups in the area. The fact that two of the authors (Mr. Wesakania and Mr. Kamau) are also farmers in the study area, manage a small tree nursery for the youth group they lead, and are knowledgeable of the local vegetation greatly facilitated species identification. All but one of the species used for milk preservation are trees common throughout Kenya with which the Kenyan authors were familiar, and for which they knew both the local and scientific names. The exception was *Lippia kituiensis* (vernacular name is ***Mwokiot*** or ***Mwokyot*** in

Kipsigis), which was identified through Beentje (1994: 668). The identification of all species, however, was verified through consultations of Beentje (1994), ICRAF (1992), Gachathi (1989) and Teel (1984). Additional botanical information on the species was obtained from the Missouri Botanical Garden's W^3 Tropicos VAST nomenclatural database and authority files on the Internet (MOBOT, n.d.).

RESULTS AND DISCUSSION

Study area.–The study was conducted in Kwanza and Cherangani Divisions of Trans-Nzoia District in Western Kenya. The district covers 2,468 km^2 and has an elevation averaging 1800 m asl. Most of the rivers in the district are tributaries of the Nzoia River and flow throughout the year. The district has a highland equatorial type of climate with a fairly well distributed average annual precipitation of 1120 mm, and an average mean temperature of 18.6° C.

The District Development Plan (DDP) of 1994 estimated the district's population at 462,748. Although no concrete data exist as to the exact numbers, there has been a steady in-flow of migrants from different parts of Kenya in the last 30 years (DDP 1994). This was confirmed by the fact that 98% of the farmers interviewed migrated to the district in the last 32 years. The main attraction for migrants into the area was the availability of land for settlement and a favorable climate for both cultivation and livestock.

The tenure system in the area has changed over the years. Initially, much of the land belonged to large individual farmers, mostly British settlers. After Kenya's Independence in 1963, these settler farms were sold as group farms to individual small holders, or were expropriated by the government for settlement schemes and co-operative and corporate farms owned by the Agricultural Development Corporation and the Kenya Seed Company, among others. These large farms have in the recent past been subdivided and given out to individual (mainly small-holder) farmers, although a large number of these are not registered and farmers do not have title deeds to their land.

The total area under forest in the district is 50,292 hectares, but immigration and settlement have led to serious deforestation in many parts of the district. The incorporation of trees and shrubs in the farming systems has partly mitigated the loss of natural forests. Agroforestry has become one of the primary production activities in the district, supplying the bulk of the about 500,000 m^3 of fuel wood consumed annually (DDP 1994). Demand for fuel wood is bound to increase due to an increasing population. Through the combined efforts of the Forest Department and NGOs, over four million seedlings are produced and supplied to farmers annually to meet the growing demand for fuel wood and other tree products. The survival rate has, however, been very low, not exceeding 30% each year according to Forest Department and extension personnel. One of the reasons for the low survival rate is that seedlings provided are mostly exotics with no cultural importance, leading to a lack of proper care to ensure survival.

Dairy farming is a major economic activity and constitutes a large proportion of income for both the small and large-scale farmers. Farmers experience problems in the marketing of their milk due to lack of storage facilities and a poor

transportation system. The dairy market is poorly developed in the district, with Kenya Cooperative Creameries (KCC) being the only commercial buyer of milk produced in the area; delayed payments for milk delivered to KCC exacerbated the problems experienced by farmers during much of 1995 and 1996. The need to treat and preserve milk at the farm level has, therefore, increased in importance despite the availability of modern milk processing facilities in Kenya.

Problems that led to uses of trees in milk treatment.–The use of trees in milk treatment is a common practice among farmers in Trans-Nzoia District. The technology has been practised for a long time by pastoral communities, and non-pastoralists (e.g., the Kikuyu) have adopted this practice from them. The farmers identified the following problems and conditions leading to their experimentation with milk treatment:

- Milk is a major source of food for pastoral people, but many Africans are lactose intolerant. Fermentation is, therefore, necessary to improve the digestibility of milk.
- The odour, taste, and flavour of fresh milk are not pleasing (farmers are of the opinion that fresh milk smells and tastes like cow urine) and need to be improved before it can be consumed. The charcoal helps to neutralize the undesirable odour and taste of the milk. Shalo (1987) reported that the finely divided charcoal inside the gourds has a wide surface area, and hence is very active absorbent of flavours in milk. The charcoal itself also imparts flavour to the milk (Shalo, 1987)
- The white colour of milk is not acceptable to farmers, who accord a high aesthetic value to the bluish-grey colour imparted to the milk by the charcoal. Similar findings were reported by Anon. (1994) and Shalo (1987).
- Lack of markets and refrigeration, and the need to store milk for the dry season (when milk production decreases due to a lack of pasture) required that excess milk be stored for longer time. There was, therefore, a need to preserve the milk and improve its shelf-life. For example, the Pokot developed ***chekha mwaka***, a specially treated milk that could be stored for over one year without spoiling (findings from interviews for this study). This is much longer than the up to 3 month shelf-life reported by Ronoh (1987) earlier.
- Gourds were and still are the best storage facilities to the farmers; they are cheap and easily available. However, gourds give milk stored in them a bitter taste. Moreover, gourds are hard to clean and produce a bad smell that affects the milk stored in them. Thus, treatment of milk was also necessary to neutralize the bad smell and bitter taste of the gourds.

Table 1 summarizes the reasons cited by respondents of why they treat their milk. Enhancement of taste and flavour was cited by 86% of the respondents as a reason for treating milk, although it was more important to farmers in Cherangani (92%) than to farmers in Kwanza (79%). The second reason cited was palatability (in the sense of being merely agreeable (WWWebster Dictionary, 2000) (75%), followed closely by the necessity of preserving the milk (cited by 73%). Again, there

are differences between the two Divisions, with preservation being more important to Cherangani farmers (83%) and palatability being more important to Kwanza farmers (79%). The differences between the two Divisions are largely due to the ethnic affiliations of the respondents. The medicinal value of treated milk was cited by 18% of respondents, but was more important in Kwanza (25%) than in Cherangani (14%).

The medicinal properties attributed to treated milk are imparted to it through the use of tree species that are known to cure diseases in animals or people. Medicinal tree species are the most frequently used species for milk treatment, as will be shown later. New species are often identified through already known medicinal use. We also surmise that fermented milk may be beneficial to establishing a healthy intestinal flora, which is similar to the use of yoghurt for this purpose in Western cultures. Shalo (1987) mentioned that charcoal, being a material intermediate between wood and ash, contains minerals that will benefit the nutritional value of milk which may, unintentionally, contribute to the overall health of its consumers.

Milk treatment procedure.– The first step in the treatment process involves the preparation of the milk storage gourds. Women use the stalk (central nerve) of palm leaves to scrape the inside of the gourds to remove old fat and milk solids that cannot be removed by washing only. A few days before milk is to be treated, a small branch of a selected tree species, about the thickness of a thumb, is debarked and left to dry. One end of the dried piece of wood is then put in the fire to burn. When the end is completely burnt, it is gently crushed on the side and bottom of a cleaned milk storage gourd to crush it into charcoal dust. This procedure is repeated several times until the gourd is completely coated on the inside. The excess dust is removed, and the gourd is then ready for milk storage. The quality of ***mursik*** (treated milk) obtained through this process is evaluated using the criteria of colour, smell and taste of the final product. Farmers claimed that their traditionally treated milk was superior to untreated milk or factory-processed milk from KCC.

A question in the community workshops about when the process was first used led to much lively discussion. Tracing oral histories and using age groups, participants agreed that the earliest reference would place its development about 300 years in the past. As there are no written documents to verify this, we ac-

TABLE 1.– Problems and conditions underlying the need for milk treatment.

Condition/problem	**% of respondents**		
	Total (n=60)	**Cherangani** (n=36)	**Kwanza** (n=24)
Taste/flavor	86	92	79
Palatability	75	83	58
Preservation	73	72	79
Smell	65	67	63
Color	55	14	25
Medicinal	11	50	63

NB: Multiple responses were allowed.

cepted this as a reasonable date although the technology could in fact be much older. According to the farmers present at the discussion, little has changed in the treatment procedures over time, although the species used have changed especially after people migrated to new areas where old, favoured trees could not be found.

Tree identification and selection procedure.– According to oral histories collected during the exercise, the identification, selection and recommendation of the tree species and their parts to be used in milk treatment was a systematic exercise. It involved the participation of both men and women, but the role of men varied between communities. For example, among the Kikuyus (a traditional farming community), the men are involved in both identification of suitable species and the treatment of the milk. In traditional pastoral communities (for example, Kalenjin and Pokot), both men and women are involved in identification of suitable tree species, but only women would do the actual milk treatment. It should be noted, though, that over time the role of men in the exercise has gradually declined in these communities; women are now solely responsible for the development, implementation and maintenance of the technology.

Not all tree species are suitable for milk treatment. The choice of species and the tree parts to be used are based on: (1) the availability of the species from natural forests or tree patches, and (2) prior knowledge about the species, particularly their use for medicinal purposes for both livestock and human beings, or fodder for livestock. The selection process of potential milk treatment tree species involves smelling the leaves of the tree and/or the smoke produced when burning a branch of candidate species. It can also involve the chewing of specific tree parts such as leaves, stem, and bark. Species that produce a pleasant smell and have a good taste, are easy to burn and produce a porous charcoal to facilitate its crushing inside the gourds will be tried on milk on an experimental basis. Whether the tree would be adopted for the purpose of treating milk depended on the quality of the initial treatment trial; evaluation criteria to judge the results of the trial emphasized the quality of the treated milk in terms of taste, colour, smell and shelf-life.

Presently, farmers use the following tree species for milk treatment (in order of preference obtained through a ranking procedure): *Senna didymobotrya* (Fresen.) Irwin&Barneby (syn. *Cassia didymobotrya* Fres.), *Lippia kituiensis* Vatke, *Prunus africana* (Hook.f.) Kalkm., *Olea europaea* L. ssp *africana* (Mill.) P.Green, *Croton macrostachyus* Del., *Olea capensis* L., and *Rhus natalensis* Krauss. Several other species are used as well, but by few farmers (Table 2); they include *Euclea divinorum* Hiern., *Dombeya torrida* (J.F. Gmel.) P.Bamps ssp *torrida* (syn. *D. goetzenii* K. Schum.), *Bridelia micrantha* (Hochst.) Baill., and *Acacia gerrardi* Benth. A few exotic species have been experimented on by women in the recent past (e.g. *Acacia mearnsii* DeWild. and *Eucalyptus* spp). *A. mearnsii* (black wattle) was found to have side effects on men, namely the blockage of the urinary tract, while *Eucalyptus* spp were found to be ineffective for the purpose and giving the milk a bad taste (which some farmers described to be similar to cold medicine). These species have therefore been abandoned for use in milk treatment by the communities who tried them (e.g., the Kalenjin). Most of the above species are grown on the farm, but some can be found only in the dwindling natural forests of the district.

Domestication and management of tree species used in milk treatment. – Generally, where farmers have chosen to voluntarily grow trees on their farms, the species planted are carefully selected. In the study area, farmers' choice of species varied according to gender, with men favouring species that provide income (from the sale of charcoal, poles, posts and timber) and women favouring species used in milk treatment or meeting fuelwood needs. It was found that among women, trees which could be used for milk treatment (e.g., *Senna didymobotya*) were preferred over species with a narrow fuelwood focus. However, women considered fuelwood of such species as a valuable secondary product. Because ***mursik*** has a special cultural meaning for women and is important to the welfare of the family, trees that were used to provide milk treatment ingredients were better taken care of by the women than trees providing other products. Species used for milk treatment are nowadays managed primarily by women, but all the members of the household will respect and take care of the trees. Men appreciate the important role of these species in the household economy and will (and can) not cut them for other purposes.

Among communities where milk is a traditional and main source of food (such as the sedentary pastoralists) and where immediate storage and marketing facilities are lacking, trees used for milk treatment are not used for fuelwood or any other purpose. They are planted and managed solely for the purpose of milk treat-

TABLE 2.– Domestication of trees used for milk treatment.

Species	**Households using** (n)	**Households cultivating** (n)	**Off-farm source** (n)	**Other uses**
Senna didymobotrya (Fresen.) Irwin & Barneby (syn. *Cassia didymobotrya* Fres.)	36	39		Fw, M
Lippia kituiensis Vatke	34	34	Neighbor 1	Fw, M
Olea europaea L. ssp *africana* (Mill.) P. Green	27	3	Forest 6	Fw
Olea capensis L.	22	6	Forest -	Fw
Prunus africana (Hook.f.) Kalkm.	18	13		Fw, M, O, P
Rhus natalensis Krauss	7	10	Forest 4	Fw, P
Euclea divinorum Hiern.	3	11	Forest 4	Fw, P
Dombeya torrida (J.F. Gmel.) P. Bamps ssp. *torrida* (syn. *D. goetzenii* K. Schum.)	9	15	Neighbor 1	Fw, O, P, R
Acacia gerrardi Benth.	1	-		Fw, P
Acacia mearnsii DeWild.	5	6	2	Fw, P
Eucalyptus spp	5	27		Fw, P, T
Bridelia micrantha (Hochst.) Baill.	3	13		Fw, P
Croton macrostachyus Del.	5	28		Fw, O, P

Abbreviations: Uses: Fw = Fuel wood; M = Medicinal; O = Ornamentals; P = Poles, posts; R = Ropes; T = Timber

ment. In some communities, it is also taboo to cross-over or step on pieces of wood cut for the purpose of milk treatment.

The trees commonly used in milk treatment were found either scattered in the fields or growing around the homestead. There was a good relationship between the three most preferred species as identified in the preference ranking exercise and the presence of these species on the farm (Table 2). *Olea* spp. were widely used for milk treatment and demand for the species was high, but few households cultivated them because of their difficult propagation and management. On the other hand, species like *Eucalyptus* spp and *Acacia mearnsii* ranked very low for milk treatment, but were very common on the farm as they are easy to propagate and manage. The latter species were managed by men, who planted these fast-growing species for income generation through the sale of fencing posts, small timber and charcoal.

In the two divisions, 44 percent of the farmers cultivated all the species they use for milk treatment within their farms; 39 percent cultivated some but not all the species used. The remainder of the farmers (17%) did not grow any milk treatment species on their farms, but instead collected them from common property resources. *Senna didymobotrya* and *Lippia kituiensis* were the most popular species used for milk treatment. Sixty percent of the farmers had planted *Senna didymobotrya* in their homesteads, while fifty-seven percent maintained *Lippia kituiensis* in their fields. *Prunus africana* is another important species used for milk treatment across communities; over 20 percent of the farmers interviewed are cultivating it on their farms.

Senna didymobotrya was planted primarily around the homesteads to enable women to: (1) protect it from browsing livestock; (2) lop some branches whenever they prepared ***mursik*** without having to walk long distances; and (3) minimize interference of the trees with other crops and farming activities including mechanization. The management techniques to maintain the species included protection against livestock, planting using seeds (for all species except *Lippia kituiensis*), and pollarding and thinning to control overcrowding and to stimulate the trees to grow many small branches for use in milk treatment.

Constraints.–Several constraints were identified regarding seed collection and storage, breakage of seed dormancy, and the management of trees. According to the farmers, many indigenous species do not produce seeds, making their propagation difficult. Those that do produce seed may take a long time to reach maturity, as is the case with *Olea capensis* and *O. europaea* ssp. *africana*. Most farmers stated that milk treated with *Olea* species tasted the best but they had to look for alternative species because few trees of these species were remaining in the area. A Gikuyu farmer explained how her husband had brought a piece of olive wood from Kiambu District (over 600 km from Cherangani Division) and how she wisely used that piece for nearly one year in treating her milk. Farmers who do have a few olive trees left on their land carefully guard them and do not allow further cutting. The remaining specimens, often located on grazing fields or near river banks, are carefully protected by the population.

A second problem is access to, and availability of, seedlings of useful and preferred species as they are rarely found in village tree nurseries or the nurseries of

the Forest Department and NGOs. The farmers felt that many times their species of priority were not available in the local nurseries, leading them to plant trees about which they had very little local knowledge. This may be one of the reasons why the survival rate of seedlings was very low.

Farmers' research activities on milk treatment.– At the time of the study, farmers stated that they were experimenting with various technologies to solve problems and constraints encountered with the cultivation of species used for milk treatment (as mentioned in the previous section). For example, some species well-liked for milk treatment such as *Olea europaea* ssp. *africana, O. capensis* and *Rhus natalensis* have become extinct on many farms (see Table 2 for the number of households growing these species) and have become rare in the neighbouring natural forest of Mount Elgon. Farmers continue their investigations of the multiplication of indigenous trees which are difficult to propagate due to lack of seeds and/or germination problems, for example *Lippia kituiensis* and *Olea* spp. Some farmers tried to plant cuttings and wildlings (i.e., seedlings collected from natural forests in the area) of *Olea* spp and *Rhus natalensis,* but without much success; however, they continue trying to augment the number of these species on their farms.

L. kituiensis is difficult to propagate because the seeds are very small and therefore difficult to collect. Farmers have also experienced problems getting the seed to germinate; according to them, the species does not germinate and grow on crop land but only in pastures. It was surmised that this could be caused either by the breakage of seed dormancy when seeds pass through the digestive system of animals, or by the seeds being buried too deeply in cultivated fields so that they would not germinate. Research attention to solve this problem would be much appreciated by farmers, as it was presently a much favoured species for milk treatment.

In addition, farmers are engaged in a continuous search for new medicinal plants both for human beings and livestock because the prices of drugs have escalated with a simultaneous decline in the quality of veterinary and health services. Eventually, some of these medicinal species may be tried and used for milk treatment, as many of the species presently used for milk treatment were identified through their prior use as medicinals.

Information sharing.– Although farmers were (and some still are) actively engaged in experimentation on the use and management of trees, they are not sharing findings in any formal, organized methods of communicating information between or within different communities. These findings are similar to findings from research by den Biggelaar (1996) and Sperling *et al.* (1993) in Rwanda. Farmers and communities do learn from each other through informal channels such as observation of each other's practices on the farm and discussions at social gatherings and ceremonies. For example, farmers influence each other in the choice of tree species to plant through these informal ways of sharing information. Mostly, the information shared between communities concerned species with common economic uses such as fuel wood or milk treatment. Information on other, non-economic uses (for example, on medicinals), was rarely shared, as such uses were more tied up in cultural and social believe systems.

CONCLUSIONS

Based on oral history recollections by farmers, the procedures for the treatment of milk have not changed much during the last 300 years, and, besides a change in species used over time, little innovation has taken place to improve them. Milk treatment remains largely a trial and error affair, in which the result cannot be obtained until the milk is ready for drinking, which is expensive in terms of time, money and milk (sometimes milk is lost because of adverse effects or unsuccessful treatment). The technology, therefore, appears to be 'static': There is either no need or opportunity for improving the process, or farmers depend on outside assistance for the further development of the technology (in the form of material, advice or ideas) which is not forthcoming. Innovations in milk treatment that did occur relate largely to the search for alternative species (which was sometimes successful) to treat milk because favored trees became scarce in the environment, or because species encountered in Trans-Nzoia were different from those found in areas where farmers migrated from. The main conclusion from this case study (which was supported by the findings of the other studies in East Africa; e.g. den Biggelaar 1996a; Aluma *et al.* 1996; Njoka and Makenzie 1996) is that knowledge generation is the rule (each time milk is treated is different and a learning experience from which new knowledge is obtained), but innovation is the exception. Networking with other pastoral people both within and outside Kenya (among communities not represented in Trans-Nzoia District such as the Maasai, Somali, Turkana and Samburu; Karamajong and Bayankole in Uganda; and Peul, Touareg, Fulani, Tutsi and Somali and other pastoralists in other parts of Africa) is recommended as one means to improve the technology. It may lead to new ideas, methods and species to be used for milk treatment by encouraging horizontal learning and communication among communities around a theme of common interest.

The goal of FAO's Farmer-initiated Research and Extension Practices initiative was to study and document local (agro)forestry knowledge and technologies with local people and communities in order to facilitate the identification, implementation and evaluation of people's own priorities for tree growing. Following findings of Scherr (1992, 1993) and van der Ploeg (1991), the initiative aimed at generating more reliable research and extension agendas than top-down approaches, assuring that technologies that research does develop are more client-oriented, have greater local relevance, and are better grounded in local dynamics of socioeconomic development. In view of the recommendations of Scherr and van der Ploeg, and in according to Objective 2, this study identified several opportunities for research and extension to collaborate with farmers in three areas which farmers themselves considered key to the continued use and further development of milk treatment: (1) collaboration to solve problems of propagation of favored tree species (i.e., seed dormancy, low and/or difficult germination, availability of seed); (2) sssistance to farmers to raise their own seedling of these species to ensure a long-term, sustainable supply; and (3) investigations into possibilities for expanding the scale of ***mursik*** production and marketing (i.e., studies looking into the demand and supply situation, ***mursik*** quality and storage ability in relation to the different species used to treat the milk, the potential markets for ***mursik***

within and without Trans-Nzoia District, and consumer acceptance of milk not treated by someone from their own ethnic community). The collaboration between farmers and researchers in solving these issues will not only increase the relevance of ongoing scientific agroforestry research and development but more importantly, it will empower, legitimize and enhance the existing endogenous capacities for identifying problems and developing solutions (den Biggelaar 1991).

One issue that is not resolved is the dissemination of innovations and technologies. Farmer-to-farmer extension, even though highly touted in the literature as a promising and cheap(er) alternative to formal extension services, was found to be all but absent in each of the four East Africa studies of the FTPP initiative (Aluma *et al.* 1996; den Biggelaar 1994, 1996a; Mureithi 1996; Njoka and Makenzie 1996). The absence of information and technology sharing was also observed by Sperling and Loevinsohn (1991) in Rwanda, and den Biggelaar (1996b) in Kenya. In addition, formal agroforestry extension activities in the Kwanza and Cherangani Divisions were virtually non-existent, while agricultural and livestock extension activities left a lot to be desired. More investigations and discussions on the role, function and form of both formal and informal dissemination practices is necessary to determine the best ways of informing people of new technologies and innovations, and to share research results.

NOTES

[1] Not all trees identified for use in milk treatment would be considered trees in the Western world view. In Bantu philosophy, however, there is only a distinction between trees (all plants that are not grasses) and grasses (all plants that are not trees) (Kagame, 1958). As the definition of Kagame better reflects farmers' conception of reality, we have adopted it in this study.

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FAUNISTIC RESOURCES USED AS MEDICINES BY ARTISANAL FISHERMEN FROM SIRIBINHA BEACH, STATE OF BAHIA, BRAZIL[1]

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ABSTRACT.– Artisanal fishermen from Siribinha Beach in the State of Bahia, Northeastern Brazil, have been using several marine/estuarine animal resources as folk medicines. We have recorded the employment of mollusks, crustaceans, echinoderms, fishes, reptiles, and cetaceans, and noted a high predominance of fishes over other aquatic animals. Asthma, bronchitis, stroke, and wounds are the most usual illnesses treated by animal-based medicines. These results corroborate Marques' zootherapeutic universality hypothesis. According to him, all human cultures that present a developed medical system do use animals as medicines. Further studies are requested in order to estimate the existence of bioactive compounds of pharmacological value in these bioresources.

Key words: Fishermen, marine resources, medicine, Bahia, Brazil

RESUMO.–Pescadores artesanais da Praia de Siribinha, estado da Bahia, Nordeste do Brasil, utilizam vários recursos animais marinhos/estuarinos como remédios populares. Registramos o emprego de moluscos, crustáceos, equinodermos, peixes, répteis e cetáceos. Observou-se uma alta predominância de peixes sobre outros animais aquáticos. Asma, bronquite, derrame e ferimentos são as afecções mais usualmente tratadas com remédios à base de animais. Estes resultados corroboram a hipótese da universalidade zooterapêutica de Marques. De acordo com ele, toda cultura humana que apresenta um sistema médico desenvolvido utiliza-se de animais como remédios. Estudos posteriores são necessários a fim de avaliar a existência de compostos bioativos de valor farmacológico nesses biorrecursos.

RÉSUMÉ.– Les pêcheurs artisanaux de la plage de Siribinha dans l'état de Bahia, au nord-est du Brésil, utilisent plusieurs ressources animales marines/estuarines en tant que médecine populaire. Nous avons enregistré l'emploi de mollusques, de crustacés, d'échinodermes, de poissons, de reptiles et de cétacés. Nous avons noté une prédominance élevée de poissons par rapport aux autres animaux aquatiques. L'asthme, la bronchite, les attaques, et les blessures sont les maux les plus habituellement traités par les remèdes à composante animale. Ces résultats corroborent l'hypothèse d'universalité zoothérapeutique de Marques. Selon lui, toute culture humaine qui présente un système médical développé utilise des animaux comme médicaments. D'autres études sont nécessaires afin d'évaluer l'existence de composés bioactifs à valeur pharmacologique dans ces resources biologiques.

INTRODUCTION

"Naturally, fish fauna provides remedies, amulets, spurs, eyes, parts of the mandible, fins, fats, muscles, which take part in the current sea-shore folk medicine (...)".

(Cascudo, 1972: 704)

Zootherapy is the healing of human diseases by using therapeutics that are obtained from animals, or ultimately are derived from them. As Marques (1994) states, "all human cultures that present a structured medical system utilize animals as medicines." Such a statement forms the basis of his 'zootherapeutic universality hypothesis.' Indeed, animals are therapeutic arsenals that have been playing significant roles in the healing processes, magic rituals, and religious practices of peoples from the five continents.

The medicinal interaction between humans and animals has been shown both in indigenous and Western societies all over the world (Gudger 1925; Conconi and Pino 1988; Antonio 1994; Marques 1995; van Huis 1996; Costa-Neto 1996, 1999a, 1999b). As some authors have pointed out, animal-based medicines have been utilized since antiquity (Weiss 1947; Angeletti et al. 1992; Rosner 1992), where popular remedies were elaborated from parts of the animal body, from products of its metabolism (corporal secretions and excrements), or from non-animal materials (nests and cocoons). An early record for animal-based medicine can be found in Tobias' Book (Catholic Bible), in which Raphael the Angel would have prescribed the use of a fish's liver content for the treatment of ophthalmic problems (Marques 1995).

The phenomenon of zootherapy has recently aroused the interest of many researchers from different branches of science, who have recorded this unusual cultural practice and sought for compounds with pharmacological action (Werner 1970; But et al. 1991; Bisset 1991; Faulkner 1992; Lazarus and Atilla 1993). This interest increases when it is considered that the annual global trade in animal-based medicinal products accounts for billions of dollars per year (Kunin and Lawton 1996). These authors have recorded that the investigation of folk medicines has proven a valuable tool in the developing art of bioprospecting for pharmaceutical compounds. Today from 252 essential chemicals that have been selected by the World Health Organization, 11.1% have plant origins, while 8.7% come from animals (Marques 1997).

In Brazil, an amazing number of about 300 animal species have been medicinally used. These resources can be easily found as commercial items sold by herbalists and curers in market places all over the country (Marques, personal communication 1996). In relation to marine/estuarine animals used as medicines, Marques (1995) has already recorded a total of 66 fish species in the folk medicines of fishing communities from 13 Brazilian states. According to him, the medicinal use of fish seems to be a very usual pattern in fishermen communities. Begossi (1992) has found that fish resources valued as medicines are usually considered taboos as food, perhaps so that they may be available as folk medicines (drugstore hypothesis).

Unfortunately, many of the zootherapeutic resources include threatened species (IBAMA 1989). In fact, the diminishing number of fauna species, especially from neotropical areas, through hunting, depauperation of their ecosystems, and their varied uses has been enormous that most of them are becoming extinct even before they have been studied by science (Huxtable 1992). Hence, studies aimed towards traditional knowledge on animal use and its significance to men should be undertaken in order to lead to better ways of exploiting the natural resources, thus, their conservation, so that future generations may know and manage them.

This paper provides an overview of the phenomenon by illustrating 39 zootherapeutic species that are prescribed by artisanal fishermen from Siribinha Beach, which is in the city of Conde, in the state of Bahia, Northeastern Brazil. Subsequent research needs to be done not only to confirm the presence of substances of medicinal value in these traditional remedies, but also to lead to a more ecologically sound exploration.

METHODOLOGY

Conde is a coastal city which is in the north region of the state of Bahia, northeastern Brazil (Figure 1). This region presents a humid/sub-humid climate, a mean temperature of 24.5°C, a mean annual rainfall of 1412 mm, and vegetation that is characteristic of tropical coastal areas (CEI 1994). Siribinha fishing community was chosen as the study area due to its localization, relative isolation, biological and ecosystem diversity, the lack of bibliographical knowledge about it, as well as the degree of both social and environmental impact to which it is submitted.

Fieldwork was performed from March 1996 to March 1998. Cultural data on zootherapy were obtained through tape-recorded, open-ended interviews carried out with 54 informants, both male and female. The informants were questioned about zootherapeutic species, the raw materials used, modes of elaboration and administration of the folk remedies, as well as the diseases for which the folk remedies are prescribed. Native words were used in order to generate a confidence relationship between interviewer and interviewees. The interviewees were asked whether recording the conversations and taking photographs were permitted.

The medicinal use-value of each animal were estimated according to the following equation:

$$UV = (\sum RM \times C)/ N,$$

UV represents the medicinal use value, RM refers to the total number of raw materials extracted from individual animals, C refers to the number of times which a particular animal has been cited, and N refers to the total number of informants questioned about zootherapy. Phillips and Gentry (1991, cited in Cotton 1993) developed this quantitative method in order to calculate the relative usefulness of different plant species within a given community.

Medicinal raw materials were collected and then catalogued and deposited at Feira de Santana State University (UEFS) with other ethnobiology collections. Some specimens that were sent to specialists for taxonomic identification were also in the collection. Crustaceans were identified by Dr. Tereza Calado (Alagoas Federal University), echinoderms by Dr. Winston Leahy (Alagoas Federal University), fish

specimens by Dr. Paulo Duarte (Laboratory of Ichthyology at UEFS), and the remaining animals were species known in this part of the country and were identified by the author using zoological references.

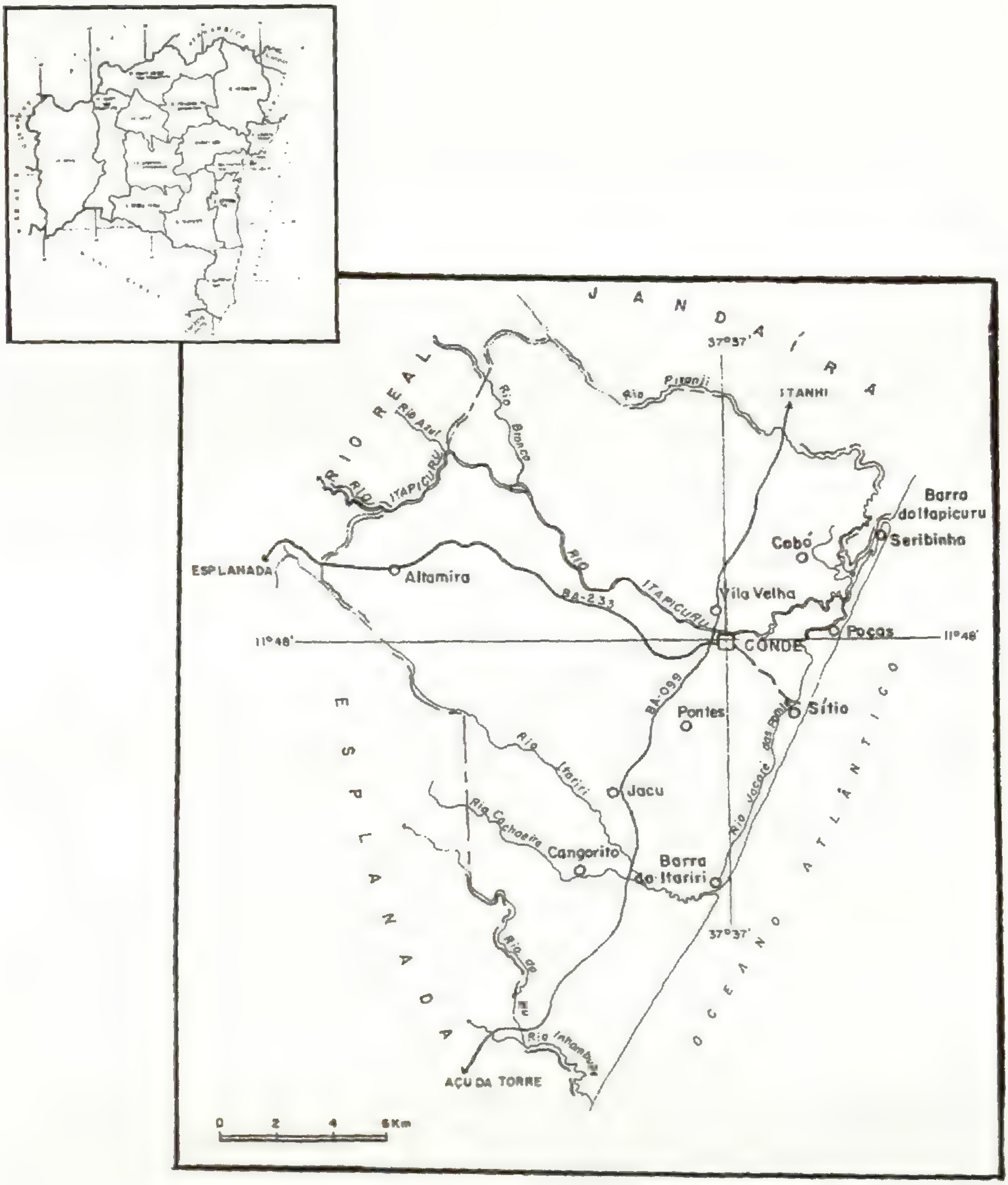

FIGURE 1. – Map showing location of the community of Siribinha where study was undertaken

RESULTS AND DISCUSSION

The medicinal use of marine/estuarine animals by the artisanal fishermen of Siribinha is one of the most consistent interactions that these fishermen perform with the local faunistic resources. Twenty-four fish species were recorded as having some therapeutic use when the fishermen were questioned about their folk medicine. Although interviews focused on fish-based medicines, fifteen other animals with medicinal properties were also cited. This makes up a total of 39 resources, which are distributed in six scientific taxonomic categories, such as fish (62%), crustaceans (13%), reptiles (10%), echinoderms (8%), mollusks (5%), and mammals (2%). Zootherapeutic species, the raw materials utilized, and diseases for which they are prescribed for are found in the Appendix.

A total of 66 raw materials including scales, spur, shell, fat, skin, globe of the eye, tentacles, otolith are used in the elaboration of remedies to treat locally diagnosed ailments. All of these resources, except the whale products, are relatively easy to obtain through hunting, fishing, or manual gathering. As can be seen in the Appendix, folk remedies are administered to the patients in the form of plasters, teas, smokes, and food. Teas, for example, are made by grinding the toasted or scraped parts of the body of the animals into powder or utilizing the whole toasted animal. Such is the case with echinoderms (starfish, sand dollar, and sea urchin) and syngnathids (seahorse). Fats, which are derived from 17 different animals, are the most usual medicinal resources and are recommended to treat a variety of diseases. As one fisherman observed, "the fat of a sea turtle sustains and heals any disease." The great majority of the animals utilized in local medicine provide only one raw material, which is prescribed for the treatment of specific diseases. This is the case with squid, whose toasted internal shell is recommended for asthma.We found that queen triggerfish (*Balistes vetula*), sea turtles (*Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, and *Lepidochelys olivacea*), and toadfish (*Thalassophryne nattereri*) were the most significant zootherapeuticals, with medicinal use-values (UV) of 0.92, 0.81, and 0.72, respectively. Although some zootherapeutic species generated indices lower than 0.50, these were both medicinally and culturally significant resources since a relatively high number of interviewees cited them. Such is the case with long-snout seahorse (*Hippocampus reidi*), with a UV value of 0.44, octopus (*Octopus* cf. *variegatus*), with UV value of 0.14, squid (*Loligo* sp.), with a UV value of 0.04, Atlantic tarpon (*Tarpon atlanticus*), with a UV value of 0.25, remora (*Echeneis naucrates*), with a UV value of 0.29, sharks, with a UV value of 0.29, and catfish (*Bagre bagre*, *Sciadeichthys luniscutis*, and *Netuma barba*), with a UV value of 0.12. The low rank of these species results from the fact that they do not represent multiple-use medicinal species.

Fishermen also use live fish, such as swamp eel (*Synbranchus marmoratus*) and cascarudo (*Callichthys* cf. *callichthys*). The former, with a UV value of 0.04, is prescribed for bronchitis and to make an infant child walk sooner. The latter, which presented a medicinal use-value of 0.02, is recommended for asthma and umbilical hernia. By spitting into their mouth and leaving them alive in the river, it is believed that these fish take bronchitis and asthma away; a child is thought to walk sooner by rubbing the fish over its legs; and cascarudos are recommended as food for the treatment of umbilical hernia. The procedure of applying live fish to

someone's body or spitting into a fish's mouth and then freeing it is a common practice both in Brazilian and other folk medicines (Branch and Silva 1983; Begossi and Braga 1992; Marques 1995). The placement of live fish under the soles of patients suffering from jaundice or similar ailment was already cited by Shimshon Morpurgo in his book *Responsa* published in Venice in 1743 (Rosner 1992: 190).

Fishermen have a singular way to treat themselves from the injuries caused by poisonous fish, especially the toadfish (*Thalassophryne nattereri*). This fish has hollow opercular spines on its dorsal fin that are associated with bulky poison glands. Due to its bentonic habit, since it lives buried under the mud or sand in shallow waters, fishermen sometimes tread on it; the fish defends itself against the careless passer-by by injecting its poison in the person's sole. In order to avoid pain and other more serious complications, fishermen take the fish's globe of the eye ("goga do olho") immediately after contact and rub it on the injured area. Guilherme Piso, a Dutch doctor who came to Brazil in the company of Prince Maurício de Nassau in 1695, stated that "This fish is considered as having the remedy to its own poison in itself" (Piso 1957: 51). This kind of preventive medicine is performed with catfish (*Bagre bagre, Sciadeichthys luniscutis,* and *Netuma barba*) and the queen triggerfish (*Balistes vetula*). Another way of avoiding the pain caused by the toadfish sting is to eat the toadfish it without salt. In doing this, fishermen say they are immunized against its poison. According to the users' testimony, it can be hypothesized that analgesic substances are indeed present in the bodies of these fish species. Further studies are requested in order to test this. According to Norse (1993), the chemical identities of the toxins of poisonous fish are still being determined.

We noted some similarities between the zootherapeutic healing practices currently found in Siribinha Beach and in other fishing communities. For example, Begossi and Braga (1992) have recorded the medicinal use of ray by the fishermen from Tocantins River. Its sting is used for the treatment of asthma, cough, cold, and pneumonia. In the state of Alagoas, fishermen use the sting to treat themselves for pneumonia (Marques 1995). In the Amazon folk medicine, the oil extracted from the liver of the ray *Potomotrygon hystrix* is used for the treatment of hernia and asthma (Branch and Silva 1983). In Siribinha, stingrays (*Myliobates* sp.; UV = 0.02) are also used in the folk veterinary medicine by employing the powder of a toasted sting to heal domestic animals' wounds.

A prescription involving toasted seahorses (*Hippocampus* spp.) is also both geographically and historically well disseminated. According to Botsaris (1995), the African slaves introduced the practice of using syngnathids as medicine in Brazil. As a result, these fish have been recommended in Afro-Brazilian traditional medicine as a tonic to treat physical debility, impotence, and asthma as well as rheumatism, bronchitis, and gastritis (Lages-Filho 1934; Marques 1995). The medicinal use of seahorses in Brazil has been confirmed in at least eight states, Alagoas, Espírito Santo, São Paulo, Paraná, Bahia, Santa Catarina, Piauí, and Rio de Janeiro (Marques 1995). In Siribinha Beach, toasted seahorses have been used in cases of asthma. Clinical and pharmacological research carried out on mice, with alcoholic extracts of *Hippocampus,* led to a weight increase of the uterus and ovaries and a prolongation of the estrogen period in females, while in males it caused an in-

crease in the weight of the prostate and testicles, and a prolongation of the time of erection (Botsaris 1995).

Other fish species are used medicinally, including the cod (*Gadus* cf. *marhua*; UV = 0.04), whose skin is put on furuncles, the curimata (*Prochilodus* sp.; UV = 0.02), whose fat is used as a plaster to treat boils, the electric ray (*Narcine brasiliensis*; UV = 0.05), whose fat is used for treatment of toothache, the grunt (*Haemulon* sp.; UV = 0.02), whose liver's fat is put on swollen areas, the sheepshead porgy (*Calamus pena*?; UV = 0,02), whose toasted fin is used for curing asthma, the snook (*Centropomus undecimalis*; UV = 0.02), whose toasted fat is rubbed over swollen legs, the two-spot astyanax (*Astyanax* cf. *bimaculatus*; UV = 0.02), which is recommended for alcoholism, and the trahira (*Hoplias malabaricus*; UV = 0,10), whose fat is recommended for the treatment of asthma, bleeding, boils, wounds, snakebites, and conjunctivitis. Only one informant cited the medicinal use of the croak (*Micropogonias furnieri*; UV = 0.02), although was unable to identify the disease for which this fish is prescribed.

Siribinha fishermen use five folk species of crabs. These include the mangrove crab (*Ucides cordatus*; UV = 0.02), whose fat is recommended for treating women's hemorrhage, the giant land crab (*Cardisoma guanhumi*; UV = 0.02), whose fat is used as a plaster for the cicatrization of wounds, the ghost crab (*Ocypode quadrata*; UV = 0.04), whose toasted whole body is used for asthma, the jellyfish crab (an uncollected specimen; UV = 0.04), which is also used for asthma, and the hermit crab (a pagurid; UV = 0.02), whose toasted whole body is recommended to treat women's hemorrhage. Interestingly, the powder of crab shells in infusions has been reported in the state of Alagoas, northeastern Brazil, as an anti-asthmatic (Lages-Filho 1934). Indeed, pharmacological studies have shown the presence of anti-inflammatory, antibiotic, and anti-tumor substances in the bodies of crabs (Croft 1986).

The value of animal-based medicines.– Although zootherapy is considered by some to be a weird, even absurd practice, its pertinence should be emphasized. As many researches point out, the significance of traditional medicines cannot be denied since they have become sources of drugs within modern medical science (Launet 1993; Lazarus and Attila 1993; Ferreira 1993; Marques 1997). Worldwide, a number of pharmaceutical companies have been supporting research on marine animal-derived compounds to be used directly as medicines and as new chemical structures that could be turned into remedies (Norse 1993; Fusetani 1996).

Regarding fish, several compounds have been extracted and are employed as remedies in standardized medicines (Hamada and Nagai 1995; Salte et al. 1996). Finkl (1984), for example, refers to *Eptatretus stoutii*, *Dasyatis sabina*, and *Taricha* sp. as sources of cardiac stimulants, antitumors, and analgesic, respectively. Oily fish, like cod, herring, salmon, and turbot, have a great medicinal value to human beings due to a polyunsaturated compound known as OMEGA-3. This substance helps with the prevention of arthritis (Adeodato 1997). The presence of an anticoagulant system in the plasma of Atlantic salmon (*Salmo salar* L.) and rainbow trout (*Oncorhynchus mykiss* Walbaun) has been confirmed, which supports similarities with the protein C anticoagulant system in mammals (Salte et al. 1996). Tetrodotoxin (TTX), a water-soluble guanidinium derivative, is an example of a bioactive

compound produced by marine organisms such as puffer fish "that resembles procaine in its ability to inhibit transmission of nerve cells" (Colwell 1997). When diluted it acts as an extraordinary narcotic and analgesic (Bisset 1991). Maybe due to this property, Siribinha fishermen use the liver's content (*"fel"*) of the puffer fish (*Colomesus* sp.; UV = 0.11) for the treatment of toothache, although it has a lethal venom.

In relation to crustaceans, chemists from the Federal University of Ceará, in Brazil, have developed three products that are extracted from discarded crustacean shells (lobsters, shrimps, and crabs). The biopolymers chitin, chitosan, and glucosamin are used to combat cholesterol and obesity, and regenerate cartilage and burnt tissues (Nogueira 1999).

Echinoderms are another group of marine organisms that yield a rich source of potential chemicals. Pharmacological studies have shown important active compounds in species, such as *Actinopyga agassizi* (anti-tumor), *Acanthaster planci* (antiviral), and *Asterias forbesi* (anti-inflammatory) (Finkl 1984). According to Aliño et al. (1990), there are studies indicating that the use of sea urchins as vermifuge might have a scientific basis. Echinoids have been also used to make artificial blood veins (Russel 1978, cited in Mallmann 1996). In the folk medicine of Siribinha's fishermen, teas made with the powder of the toasted sand dollar (*Mellita* sp.), starfish (*Luidia senegalensis*), and sea urchin (*Echinometra lucunter*) are commonly recommended for the treatment of asthma. These resources are very commonly used, although their UV was only 0.16.

In 1995, scientists from the Servier Research Institute in Paris discovered the way sea turtles reduce their cerebral activity while submerged in order to save oxygen (Anonymous 1995). This physiological process was referred to as the 'turtle effect'. This study on the cerebral activity of sea turtles may lead to the development of drugs against apoplexy.

Threatened species as zootherapeuticals.– Of the 39 animals considered as sources of medicine to the Siribinha fishermen, only four are officially listed as threatened species by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA, 1989). These are represented by the sea turtles, which are also cited by the Convention on International Trade of Endangered Species (http://www.cites.org). Five of the world's eight known species use the Brazilian coastline as hatcheries or feeding ground (http://www.wwf.org.br/wwfeng/wwfpr35.htm). In the Bahian territory, four species used to be widely caught and killed for both food and income by the coastal peoples, indigenous and artisanal fisherman communities, who have inhabited its coastline. Sea turtles were captured specially during the reproductive season when females come up onto the beach to lay their eggs. According to the interviewees, several turtles were hung alive for a couple of days before being killed. The eggs themselves were also taken, while their shells were used to make glasses, combs, rings, necklaces, and bracelets.

Indeed, coastal peoples all over the world fish sea turtles for subsistence and commerce. For example, the Miskito Indians from the eastern coast of Nicaragua are very dependent on green turtles (*Chelonia mydas*). They catch sea turtles for their meat, leather, shell, oil, and calipee, a gelatinous substance that is the base

for turtle soup (Nietschmann 1974). Among the coastal people of northern Mindanao and the Visayan islands of Bohol, Cebu, and Negritos in central Philippines, the flesh of green turtle and hawksbill turtle (*Eretmochelys* sp.) is cooked with vinegar, soy sauce, garlic, laurel leaves, pepper corn, and salt, and then eaten for the treatment of asthma (Aliño et al. 1990).

This extractive pressure has increased in such a way that all eight species of sea turtles are now on the endangered species list. Population growth and advanced harvesting technologies made possible the enlargement of the fishing power as well as overexploitation of natural resources. Nietschmann (1974) stated that the industrial fishing nets that were introduced in the Miskito's culture helped to kill a greater number of turtles than when these Indians solely used harpoons. Siribinha fishermen have generated their own theory to explain the diminishment of sea turtles and sharks– the shrimp trawl fishery. This fishery is primarily done by outside, motorboat fishermen, who go to their fishing grounds to trawl shrimp. Vincent and Hall (1996) have already reported the negative impacts of trawling on marine organisms. In addition to this direct human persecution, sea turtles are also the victims of environmental changes and pollution.

Due to the drastic decline of wild populations, conservation measures have been taken and legislative laws now prohibit sea turtle fishing. In Brazil, the TAMAR (*Tartarugas Marinhas*) project was set up in 1980 to protect sea turtle feeding grounds and hatcheries along the Brazilian coast (about 1,000 kilometers of beaches). This is a worthwhile project since only a few tens of hawksbill turtles breed in the northeast of Brazil, specifically on the Bahian coast. At present, TAMAR has 22 bases in eight Brazilian states, at strategic nesting and feeding points along the coast.

This relatively recent intervention, however, has raised an exogenous taboo, institutionalized by rules that have been imposed on local communities by both government and conservation agents. These rules have resulted in the disconnection of a strong human/animal interaction that has a long history. Although fishermen fear being caught by IBAMA agents and taken to jail, they undertake transgressions and break the rules. Some turtles are indeed captured and eaten, or have their eggs harvested. We had the chance to document the cultural scene in which three young fishermen butchered an adult green turtle (*C. mydas*), and extracted its flesh and oil as food and remedy respectively. According to their explanation, the turtle appeared floating in the estuary and apparently died a few hours previously due to the bite of a shark on its right flipper (*"**aba**"*). However, this incident occurred in a very concealed way because collecting wild animal species is not considered a bailable crime in Brazil.

We would also like to call attention to the importance of seahorses. Although they are not included on the Brazilian list of endangered species, they were listed by IUCN in 1996. The alleged cause of this endangerment has been the great demand of seahorse specimens for Chinese traditional medicine, aquariums, and curios (Vincent and Hall 1996). Due to their worldwide use, seahorses are becoming rare in some regions of the globe. For example, in Indonesia the population of some species has dropped to half since 1990, with pregnant males being the most common prey.

The number of seahorses is indeed diminishing in Siribinha, as can be seen in the following informant's assertion:

> We took them to the market to be sold. People bought them for remedies. We fished a lot of them. My husband used to catch several of them, which were sun-dried and tied together in a string. He sold them at the market. But you do not see my son? Even they have disappeared that we do not find them anymore. (Mrs. Zulmira, 90 years old)

We would suggest that a biostatistical study on the wild populations of seahorses and their folk-commercial importance be carried out in order to develop reliable conservation measures that are both scientifically and culturally oriented.

Zootherapy and its sustainability.– Instead of sending the practitioners of zootherapy to prisons, or creating policies which force them to abandon such practices, decision-makers should view this human/nature interaction within its cultural dimensions. The value of animal-based medicines are very significant; they are usually the main available resources for the majority of the human population with limited access to official medicines and medical care. Since people have been using animals for a long time, suppression of their use will not save them from extinction. Considering the sea turtles, Carr (1996: 127) stated that "people have been eating turtles pretty steadily for as long as they have had the wits to get them out of their shells". In addition, millions of hatchlings are caught annually for the pet market.

A growing body of literature shows that the cultural aspects of a given human/nature interrelation should be taken into account in all debates related to sustainable development (Morin-Labatut and Akhtar 1992; Sachs 1993; Agrawal 1995; Zwahlen 1996). This cultural perspective includes the way people perceive, use, allocate, transfer, and manage their natural resources (Johannes 1993). As Alcorn (1995: 20) states, "Conservation is a social and political process." In this way, discussing the relationship between food provided by the environment, their trophic use, the physiological consequences that result from their being eating, as well as the social-economical structures that support them within the multidimensionality of the sustainable development is one of the key elements to achieve sustainability (Bahuchet 1997).

Researchers should recognize that the sustainable use of natural resources due to their medicinal value is one of the ways by which biodiversity is used (Celso 1992). According to Kangas (1997), sustainable development is tied indirectly to biodiversity through the need to maintain overall environmental values. However, the demand for natural products from marine organisms can become a serious problem if collectors overexploit the typically sessile organisms (Norse 1993). Yet, we have to realize that the negative impacts on biological diversity should not be restricted only to the traditional users, but should be extended to the use by pharmaceutical industries (Marques 1997).

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NOTES

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APPENDIX.– Folk prescriptions of zootherapeutic resources used by artisanal fishermen from Siribinha Beach, state of Bahia, Brazil.

MOLLUSKS

Octopus, "Polvo" (*Octopus* cf. *variegatus*) Cephalopoda, Octopodidae
Get the "arms" (tentacles), toast them, and then grind to make a tea that is drunk for curing asthma;
The powder of the toasted "lixa" (shell rudiment ?) is used to make a tea, which is drunk to treat "doença do vento" (stroke ?);
Get the hide (skin), burn it, and breathe the smoke to heal headache.

Squid, "Lula" (*Loligo* sp. ?) Cephalopoda, Lolliginidae
Get the "stone" (internal shell), toast it, and make a tea for curing asthma.

ECHINODERMS

Sand Dollar, "Estrela-da-costa" (*Mellita* sp.) Echinoidea, Mellitidae
The whole toasted starfish is turned into a tea to treat asthma.

Sea Urchin, "Pinaúna" (*Echinometra lucunter*) Echinoidea, Echinometridae
Idem

Starfish, "Estrela-do-mar" (*Luidia senegalensis*) Asteroidea, Luidiidae
Idem

CRUSTACEANS

Giant Land Crab, "Gaiamum" (*Cardisoma guanhumi*) Decapoda, Gecarcinidae
Get the "fel" (fat?), make a plaster, and put it on wounds to help their cicatrization.

Ghost Crab, "Graucá" (*Ocypode quadrata*) Decapoda, Ocypodidae
Get a ghost crab, toast it, and then grind to make a tea, which is drunk to treat asthma.

Hermit Crab, "Caranguejo-ermitão" (Species not determined) Anomura, Paguridae
Get a hermit crab, take it away from the shell, toast it and grind to make a tea; then drink it to treat women's hemorrhage.

Jellyfish Crab, "Caranguejo-da-água-viva" (Specimen not collected) ?
The whole crab is turned into a tea, which is useful for asthma.

Mangrove Crab, "Uçá" (*Ucides cordatus*) Decapoda, Ocypodidae
Get the fat, filter it, mix it with white wine, and then drink it for treating women's hemorrhage.

FISHES

Atlantic Tarpon, "Cangurupim" (*Tarpon atlanticus*) Elopiformes, Elopidae
Get a scale, burn it, and breathe the smoke for curing "doença do vento" (stroke?), headache, and asthma.
Get a scale, toast it, then grind and make a tea to treat asthma.

Cascarudo, "Caboge" (*Callichthys* cf. *callichthys*) Siluriformes, Callichthyidae
Someone who has faith split into its mouth three times and then free it alive in the river to be healed from asthma;
Eat one in cases of umbilical hernia.

Coco Sea Catfish, "Bagre-fidalgo" (*Bagre bagre*) Siluriformes, Ariidae
Rub the globe of the eye over the area that was injured by its spur to alleviate pain.

Cod, "Bacalhau" (*Gadus* cf. *marhua*) Gadiformes, Gadidae
Put the hide (skin) on furuncles.

Croak, "Curvina" (*Micropogonias furnieri*) Perciformes, Scianidae
Get the otolith and make a tea.

Curimata, "Xira" (*Prochilodus* sp.) Characiformes, Prochilodontidae
Get the fat and make a plaster to treat boils.

Electric ray, "Peixe-elétrico" (*Narcine brasiliensis*) Torpediniformes, Narcinidae
Put the fat on the tooth to treat toothache.

Grunt, "Bonome" (*Haemulon* sp.) Perciformes, Haemulidae
Rub the fat of the liver over swollen areas.

Long-Snout Seahorse, "Cavalo-marinho" (*Hippocampus reidi*) Gasterosteiformes, Syngnathidae
Get one, let it to be sun-dried, then toast it and grind to make a tea, which is drunk in cases of asthma.

Marine Catfish, "Bagre-urutu" (*Sciadeichthys luniscutis*) Siluriformes, Ariidae
Rub the globe of the eye over the area that was injured by its spur to alleviate pain.

Pufferfish, "Baiacu-xaréu" (*Colomesus* sp.) Tetraodontiformes, Tetraodontidae
Put the content of the liver ("fel") in the tooth to alleviate toothache;
Get the hide (skin) and cover the wounds with it.

Queen Triggerfish, "Capado" (*Balistes vetula*) Tetraodontiformes, Balistidae
Get the scale, burn it, and breathe the smoke for curing stroke;
Get the fat of the liver, put it in a piece of cotton, and then introduce it inside the ear; it is useful for curing earache;
Get the spur, toast it, and then grind to make a tea which is drunk against its own venom;
The toasted fat is drunk against stroke;
Get the hide (skin), burn it, and breathe the smoke to treat asthma and stroke;
Rub the "goga do olho" (globe of the eye) over the area that was stung by its spur.

Remora, "Pegador" (*Echeneis naucrates*) Perciformes, Echeneidae
Get the sucking disk, let it to be sun-dried, then toast it and grind to make a tea which is drunk for curing bronchitis and asthma.

Scalloped Hammerhead (*Sphyrna lewini*) Carcharhiniformes, Carcharhinidae
Toast the liver, get the fat and drink it to treat asthma;
Massage fat on rheumatic parts of the body;
Rub the fat over wounds.

Sharpnose Shark, "Cação-rabo-seco" (*Rhizoprionodon* sp.) Carcharhiniformes, Carcharhinidae
Toast the liver, get the fat and drink it to treat asthma;
Massage fat on rheumatic parts of the body;
Rub the fat over wounds.

Sheepshead Porgy, "Peixe-pena" (*Calamus pena* ?) Perciformes, Sparidae
Toast the "pena" (fin ?) and grind it to make a tea for curing asthma.

Smalltail Shark, "Cação-gaia-preta" (*Carcharhinus porosos*) Carcharhiniformes, Carcharhinidae
Toast the liver, get the fat and drink it to treat asthma;
Massage fat on rheumatic parts of the body;
Rub the fat over wounds.

Snook, "Rubalão" (*Centropomus undecimalis*) Perciformes, Centropomidae
Get the fat, toast it, and rub it over swollen legs.

Stingray, "Arraia" (*Myliobates* sp.) Myliobatiformes, Myliobatidae
Toast the spur, grind it and make a tea for curing asthma;
Put the powder of the toasted spur in a broken tooth to alleviate the pain;
Toast the fat and drink it against asthma;
Put the fat over wounds.

Swamp eel, "Muçum" (*Synbranchus marmoratus*) Synbranchiformes, Synbranchidae
Split into its mouth and free it alive in order to treat bronchitis;
Rub a live fish over an infant child's legs to make him/her walk sooner.

Toadfish, "Niquim" (*Thalassophryne nattereri*) Batrachoidiformes, Batrachoididae
Get the globe of the eye and rub it over the area that was injured by its spur;
Rub the "miolo" (soft part of the head) over the injured area in order to take the pain away;
Eat three saltless roasted toadfish to prevent feeling pains in the next time when someone gets injured by its spur.

Trahira, "Traíra" (*Hoplias malabaricus*) Characiformes, Erythrinidae
Get the fat, toast it and use it for curing toothache, asthma, bleedings, boils, and wounds;
The raw fat is recommended as an antidote against snakebites;
Rub the fat over the eyes in order to treat conjunctivitis.

Two-spot Astyanax, "Piaba-mirim" (*Astyanax* cf. *bimaculatus*) Characiformes, Characidae

Get three live fish and grind them; then put the resulting mass in a white rum bottle and bury it for a period of five days. After this, make someone drink it in order to stop drinking.

White Sea Catfish, "Bagre-do-mangue" (*Netuma barba*) Siluriformes, Ariidae

Rub the globe of the eye over the area that was injured by its spur to alleviate pain.

REPTILES

Green Turtle, "Tartaruga-verde" (*Chelonia mydas*) Testudines, Cheloniidae

The fat is toasted and rubbed over wounds and bangs;
Put the fat in a piece of cotton and apply it on painful tooth;
Get a small piece of the shell, burn it, and breathe the smoke for curing asthma;
Get the rear foot, burn it, and breathe the smoke to treat stroke;
Toast the shell of the egg, grind it, and put the powder to be boiled; then cover it for a while and drink it to treat asthma;
A cooked egg is eaten for the treatment of diabetes;
Drink the toasted fat in cases of headache, cough, bronchitis, hoarseness, and asthma;
Mix the fat with honeybee and drink it to treat asthma and flu.

Hawksbill Turtle, "Tartaruga-de-pente" (*Eretmochelys imbricata*) Testudines, Cheloniidae

Idem

Loggerhead Turtle, "Tartaruga-cabeçuda" (*Caretta caretta*) Testudines, Cheloniidae

Idem

Olive Ridley, "Tartaruga-de-couro" (*Lepidochelys olivacea*) Testudines, Cheloniidae

Idem

MAMMALS

Whale (Specimen not determined) Cetacea

Put the fat on a teaspoon, warm it, and drink it against asthma;
Sit down on a vertebra in order to treat backaches.

Responding to Bioprospecting: from biodiversity in the South to medicine in the North. Hanne Svarstad and Shivcharn S. Dhillion (Eds). Spartacus Forlag As, Oslo. 2000. Pp. 220. $ 17.95. ISBN 82-430-0163-8

Responding to Bioprospecting, provides an even handed look at the cultural, economic, and environmental issues surrounding ethical and unethical biodiversity prospecting. This volume is poignant in its anecdotes and discussions that range from issues of biopiracy, to what is needed for truly ethical bioprospecting in Africa. As one moves through the fourteen essays which immediately offer a crash course in "bioprospecting 101" and beyond, the reader will be immersed in not just the polarization that influences this issue, but many of the historical nuances that come to bear on bioprospecting. The volume begins with a powerful "picture this" example, when on vacation in Norway in 1969, a Swiss scientist collects a few soil samples. After some 30 years, including 11 years of research and development, that hand full of soil has yielded a pharmaceutical company US$ 1.2 billion in sales (page 9).

Part one of *Responding to Bioprospecting* comprises the first seven chapters which provide an in depth examination of the origins of bioprospecting. The first section is silent in its analysis of the differences between bioprospecting and biopiracy. In addition, the issues confronting the commercialization of medicinal plants and concerns regarding the phytomedicine industries use of "best practices" are covered. Part two of the volume offers examples of engagement between the scientific community and traditional healers. Of particular interest are Chapter Eight's insights on a working model of bioprospecting reciprocity in Mali. The final section covers Chapters 12 through 14, which discuss legal issues that hamper denied development nations in their efforts to be equal partners in bioprospecting. While the essays in *Responding to Bioprospecting* are diverse and objective, missing is the voice of bioprospecting opponent Vandana Shiva. While Shiva is often cited in the articles, she does not have a contributing essay in the volume. Shiva would enhance *Responding to Bioprospecting* had it included a piece by her.

It remains to be seen whether or not there can be an ethical and fair engagement within the bioprospecting arena. Yet, in *Responding to Bioprospecting* the reader is presented with the often-used model of INBIO and Merck & Co in Costa Rica. There is a great deal of success and technological exchange in this particular arrangement that can be applied to other NGO/Industry agreements. But it should be understood that the Merck/Costa Rica deal is essentially a contract between a government and an industry leader and that bioprospecting takes place on governmental land reserves, hence "no work in agricultural lands or areas under management of indigenous groups" takes place (page 54). Similar situations rarely exist elsewhere. Instead, most bioprospecting efforts take place in indigenous homelands.

Although many indigenous groups have failed to benefit from past bioprospecting efforts, the volume does provide some examples of current or recent agreements in which indigenous groups and ethnic minorities cooperate with bioprospectors. An example of this cooperation appears in Chapter 10, which examines the relationship between a rural community and Shaman Pharmaceuti-

cals. This chapter illustrates the trial and error process that many traditional communities currently find themselves in when dealing with bioprospecting interests. The question that often arises is, can these communities withstand this trial and error process, and is it ethical to have unwitting communities enduring a process that can be avoided? History shows that if equitable arrangements are not agreed upon, communities find their own traditional knowledge becomes contested.

No single essay in *Responding to Bioprospecting* ties together all the variables that keep the usually one-sided bioprospecting structures in place. But by the book's end it is very apparent that this collection outlines the bi-polar positions on the issue of bioprospecting, and it details many of the undercurrents and inner-workings of this industry. To this volume's credit, *Responding to Bioprospecting* provides thorough coverage of biodiversity conservation issues. Unfortunately, it does not provide enough material regarding issues such as the loss of cultural diversity. Far too little attention is given to the cultural alterations that belie the aftermath of bioprospecting be it ethical or not. Also missing from the volume is examinations of the role advances in technology have played in making bioprospecting a lucrative industry in the last decade, and the pressure this these technological advances have on denied development countries. The failure on the part of the editors to include an essay on the role of bioprospecting and its links to health issues in both the nations of the North and South should not be seen as blind omission. Such oversights are often corrected in second editions. Given the broad array of topics covered in this volume, *Responding to Bioprospecting* is well worth the read for ethnobiologists interested in this topic.

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Aboriginal Plant Use in Canada's Northwest Boreal Forest. Robin J. Marles, Christina Clavelle, Leslie Monteleone, Natalie Tays, and Donna Burns. UBC Press, Vancouver. 2000. $29.95 (paperback), $75.00 (clothbound). Pp. 368. ISBN 0-7748-0738-5 (paperback), 0-7748-0737-7 (clothbound).

Aboriginal Plant Use in Canada's Northwest Boreal Forest describes over 200 of the traditional plants and plant products (foods, medicines, and materials for handicrafts or technologies) of the Cree, Dene, and Métis peoples living in the northwest boreal forest regions of central to Northern Manitoba, Saskatchewan, and Alberta. The book is a compilation of original ethnobotanical fieldwork and supplemental information derived from the literature (on ethnobotany, nutritive and medicinal plant value, and ecological impact and economic potential of commercial plant development).

It attempts more than simply a list of useful plants by including an extensive introductory section detailing research methods, and ecological and cultural backgrounds. Sources of related literature on boreal plant uses are also included. In addition to documenting plant uses, the objectives of the fieldwork included training Aboriginal students to conduct culturally-appropriate research within their own communities, identifying plants with the potential for sustainable harvesting and economic development, and preparing Aboriginal peoples for a role in the development process. The authors indicate their concern for maintaining Aboriginal rights to intellectual properties, and briefly outline how they attempted to respect these and other related issues (e.g., including only information that elders wished to have shared, and maintaining confidentiality by using a code to identify contributors).

The majority of the book is a listing of boreal plants and their traditional uses, organized into sections as follows: Fungi, Lichens, Nonvascular Plants (i.e., Mosses), Vascular Spore-Producing Plants (i.e., Horsetails, Clubmosses, Ferns), Gymnosperms, and Angiosperms. Plants are organized alphabetically within each section by scientific name, but English and local Aboriginal names are also included. For each plant, a 1-2 page description of the plant (including photograph), its habitat, and uses for food, medicine, technology and ritual is provided. Properties of each plant (based on the literature) that may be relevant to documented and/or potential uses are listed, and a brief assessment of the potential for economic development is provided. The appendices contain a list of contributors (coded by number, gender and cultural affiliation) and a list of voucher specimens. A glossary, list of references cited, and index are also included.

Overall, the book is informative, well-written, highly readable, and serves a broad range of academic, government, commercial, and local interests. The plant use information will be a handy resource for anyone interested in culturally-important plants of the Canadian northwest boreal forest, while the additional research methodologies, cultural information, ecological background and development potential provide a context that will enable the reader to appreciate some of the wider aspects related to documenting Aboriginal plant knowledge and use.

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FOLK CLASSIFICATION AND CONSERVATION OF BAMBOO IN XISHUANGBANNA, YUNNAN, SOUTHWEST CHINA

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ABSTRACT.— Indigenous knowledge systems concerning the classification, identification, nomenclature and conservation of bamboo resources in ethnic areas may play an important role in sustainable development. Folk classification plays an important role in the plant identification systems of national minorities of China. Indigenous peoples classify plants based primarily on plants' economic uses, morphological characteristics, life forms, growth habitats, as well as sociocultural values, which are strongly rooted in biophysical and sociocultural environments. In addition, indigenous conservation practices that result from long-term interactions between indigenous peoples and natural resources provide reasonable and efficient production systems for the sustainable utilization of bamboo resources.

Key words: Folk classification, conservation, bamboo, Xishuangbanna, China

RESUMEN.–Los sistemas de conocimiento indígenas referente a la clasificación, identificación, nomenclatura y conservación de recursos de bambú en areas étnicas podría ser un factor importante en cuanto al desarollo sostenible. La clasificación usada por los campesinos toma una posición significante en los sistemas de identificación de plantas de las minorías nacionales de la China. Los indígenas clasifican plantas basándose primordialmente en su uso económico, sus características morfológicas, sus formas de vida, sus hábitats de crecimiento, además de sus valores socioculturales que estan fuertemente radicados en ambientes biofísicos y socioculturales. En adición, los recursos naturales indígenas proveen sistemas de producción que son razonables y eficientes para la utilización sostenible de los recursos del bambú.

RÉSUMÉ.–Les systèmes de connaissance indigène concernant la classification, l'identification, la nomenclature et la protection des ressources en bambou dans les régions ethniques ont un rôle important à jouer dans le maintien du développement. La classification populaire est une dimension importante du système d'identification des plantes chez les minorités nationales de la Chine. Les autochtones classifient les plantes principalement en su basant sur leurs utilisations commerciales, leurs caractéristiques morphologiques, leurs formes de vie, leurs habitats ainsi que sur des valeurs socioculturelles fortement enracinées dans les environnements et socioculturels. En outre, les pratiques indigènes en matière de protection assurent d'une façon raisonnable et efficace le maintien de l'utilisation des ressources en bambou qui proviennent ellesmême d'une interaction à long terme entre les peuples et la nature.

INTRODUCTION

Bamboo, together with several groups of herbaceous bambusoid grass, is classified by taxonomists as the subfamily Bambusoideae within the grass family Gramineae (Poaceae). As ornamental plants and sources of raw material for papermaking, textiles, basketry, matting, rope, house construction, furniture, bridges, and fishing equipment, bamboo provides a greater diversity of uses in Asia than any other group of closely related plants (McClure 1956).

Bamboo is an important non-timber forest product (NTFP) with a high commercial value. As an important resource, bamboo has been exploited and utilized by various institutions. Heightened attention has resulted from greater recognition of the need for sustainable use of natural resources, and the need to maintain biodiversity while pursuing economic development (Williams et al. 1991). However, increasing demand for the world's bamboo resources is related to a series of threats to bamboo diversity, and has led to the extinction of a number of bamboo genetic resources. Over-exploitation and habitat destruction of bamboo genetic resources increases these threats. For example, in the Indian Himalayan region, twelve species of bamboo have been marked as rare and endangered due to biotic pressure coupled with biological phenomena such as periodic flowering, poor seed setting and indiscriminate exploitation (Biswas et al. 1997). *Qiongzhuea tumidinoda* in Yunnan is one bamboo species known for its beautiful culms (stems) and has been exported to south Asia since as early as the ancient Han Dynasty (1,200 years ago). The shoots of this bamboo species are exported to Japan and other countries every year. Due to the over-exploitation of this bamboo for various ornamental, construction, and handicraft purposes, it is now one of two species of Bambusoideae on the list of Chinese Preserved Plants.

In contrast, indigenous communities such as the Hani, Dai and Jinuo in Yunnan, southwest China have been using traditional methods and strategies of bamboo exploitation that lead to the sustainable utilization and development of bamboo resources. It is therefore important to study the indigenous knowledge systems that relate to the classification, identification, utilization, management and conservation of bamboo resources.

OBJECTIVES

The objective of this paper is to survey, describe and evaluate bamboo species that are classified and conserved by indigenous communities in Xishuangbanna, Yunnan Province, China utilizing ethnobotanical methods, and to propose approaches for the sustainable management and conservation of bamboo resources by incorporating relevant indigenous knowledge. Three objectives were therefore identified in this study: (1) to survey and collect indigenous knowledge on classification, nomenclature, and conservation of bamboo resources in indigenous communities; (2) to describe and discuss the folk classification system of bamboo; and (3) to determine and describe the conservation practices of bamboo resources by indigenous communities in Xishuangbanna, Yunnan.

STUDY AREA

The study area is located in Xishuangbanna, Yunnan Province in southwest China. Yunnan Province is an inland and remote province in southwest China, located within 21°8' - 29°15' N and 97°32' - 106°12' E. Xishuangbanna is located in the southwest of Yunnan Province, bordering Myanmar and Laos (Figure 1).

Geographically, Xishuangbanna is located at the southeast end of the Hengduan mountains– the eastern appendages of the Himalayas. Xishuangbanna lies within 21°10' - 22°40' N, and 99°55' - 101°50' E with a total area of 1,922,300 hectares, of which 94% consists of mountainous and hilly terrain, with river valleys making up the remaining area. The elevation is low in the south and high in the north; from the south to the north the elevation rises from 420 m to 2,800 m above sea level. The annual rainfall ranges from 1,138 to 2,431 mm, the annual mean temperature varies from 15°C in winter to 22°the C in the summer, and the annual mean relative humidity is between 70 - 80%. The unique landforms and complex physical conditions make Xishuangbanna a diverse ecological environment with various ecosystems. Tropical forests account for 33.8% of the total area cover. The biological resources are so plentiful that Xishuangbanna is known as "the kingdom of wild flora and fauna." Xishuangbanna is home to the vast majority of

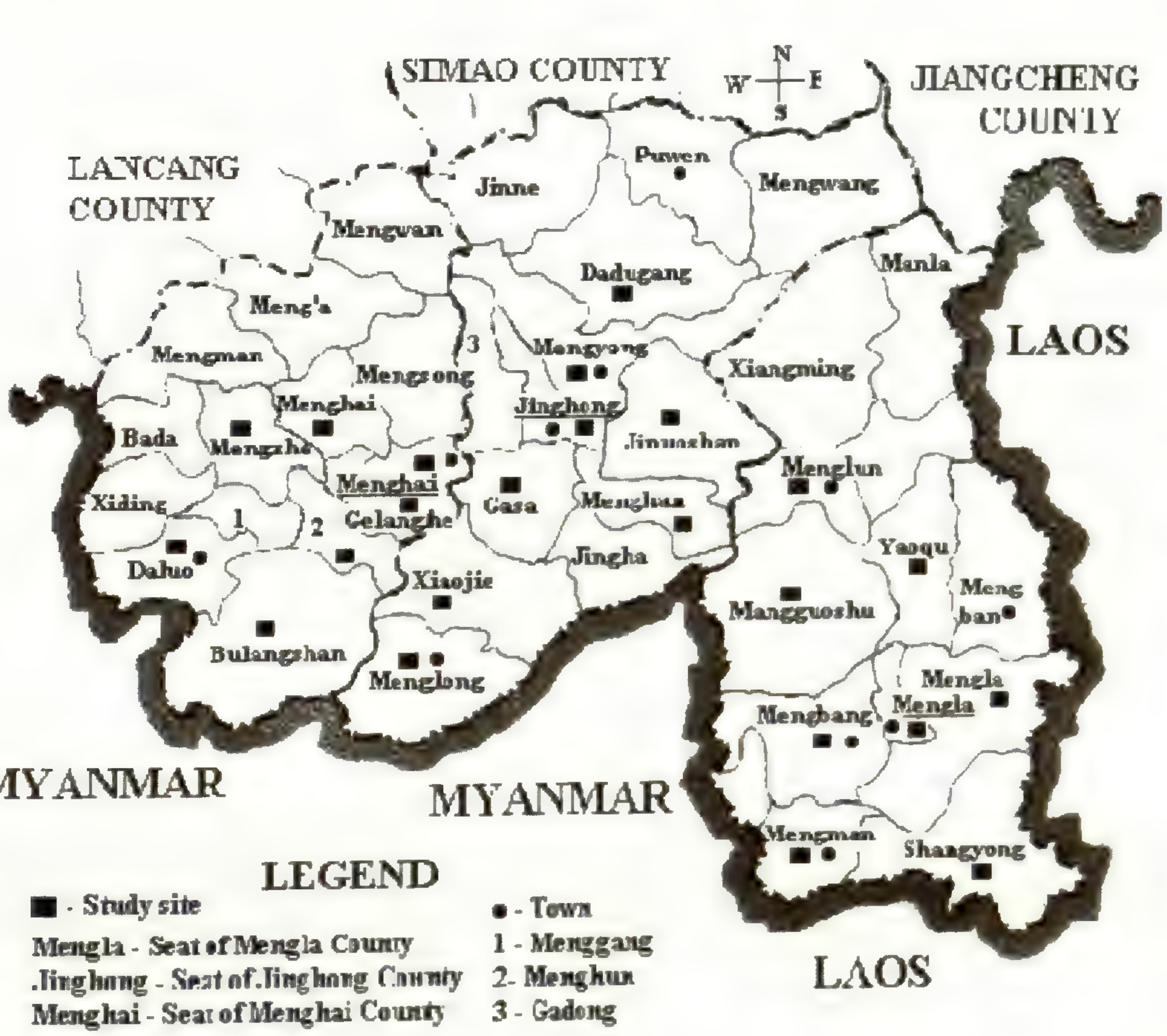

FIGURE 1.– Map of the study area and research sites in Xishuangbanna, Yunnan Province, China

plants and animal species found in China. A total of 4669 higher plant species, subspecies or varieties belonging to 1697 genera of 282 families have been recorded in Xishuangbanna (Li et al. 1996). Nearly one sixth of the total species of China (30,000 species) can be found here, although it constitutes only one five hundredth of China's total land area.

Xishuangbanna is a multi ethnic area. It is comprised of 13 different ethnic groups which include Dai, Hani (also called Aini), Lahu, Bulang, Yi, Jinuo, Yao, Wa, Hui, Bai, Zhuang, Miao, Buyi, and other unidentified ethnic groups (e.g., Kemo, Kemie, and Kongge). Each ethnic group has its own language and folk knowledge, especially concerning the utilization, management, and conservation of natural resources. Bamboo is a useful plant and its cultivation is widespread, being used by all of the ethnic communities.

METHODOLOGY

Literature search.– The first stage in this study included a background search for information, specimens, and documentation related to the taxonomy of bamboo and indigenous knowledge systems of folk classification, identification and conservation of bamboo resources.

Site visits and interviews.– The second stage involved visiting sites and interviewing local people. In this study, the sites were selected based on three criteria: species, cultural diversity, and economic diversity. The research team visited twenty three study sites (Figure 1) were visited. More than 100 local people were interviewed concerning the distribution, habit, ecological condition, and regeneration of bamboo, as well as indigenous knowledge systems of folk classification, utilization, management and conservation of bamboo. Interviews with local people were conducted in three phases. In the first phase the local leaders and experienced persons were asked to recall important and/or memorable bamboo species in the study area. This phase was usually done at night. The interviewers used a previously prepared questionnaire with simple and clear questions (Table 1, part I). The second set of interviews involved general and specific questions that were related to the species mentioned in the first interview, and were used to serve as a guide in the field survey (Table 1, Part II). The third and final phase of interview stage involved a group interview in which respected members of the local community were asked to assess the nature of use and confirm the local names of bamboo species. The study included community elders as they have a historical perspective of the use of the bamboo resources.

Field observation and specimen collection.– Information on culm habit (strictly erect, pendulous or climbing), rhizome system (sympodial or monopodial), culm characteristics (height, diameter, branching, node, internode, etc.), culm sheaths (the fifth culm sheath was characterized based on the general appearance, size, texture and shape of sheath and their blades), leaves, and inflorescence (by presentation) was recorded. This field investigation included some accurate and detailed information, such as local names and their meaning, diagnostic characteristics, distribution, special utilization and conservation practice, and so on. In addition, market data were recorded in detail.

TABLE 1.– Bamboo interview instrument

Part I: General Investigation

Village: _____ Name of Farmer:

Collector(s): _____ Date: _____ Collection No.:

How many bamboo species are in your area? (Lists of local names):

1) Wild: _____

2) Cultivation: _____

Which bamboo do you like to cultivate? (Lists of local names):

_____

Where is the bamboo cultivated?: 1. home garden, 2. swidden field, 3. bamboo garden,

4. bank of channel, 5. forest-land, 6. Other _____

How much bamboo is harvested in one year?: Culms_____; Shoots:____ kg

How do you propagate bamboo?: 1. rooted cutting, 2. rhizome-offset, 3. culm cutting,

4. branch cutting, 5. seedling, 6. Other _____

Remarks: _____

_____

Part II. Specific Bamboo Species Investigation

Vernacular Name _____ ; Meaning _____

Important Characteristics (for identification): _____

Habitat: 1. cultivated, 2. disturbed, 3. partly disturbed, 4. other _____

Rhizome Types: 1. sympodial (dense clump), 2. monopodial (scattered clump)

Culm Habit: 1. erect, 2. arching over 3. decumbent, 4. scandent / climbing

Culm: 1. height ____m, 2. diameter ____cm, 3. thickness ____cm, 4. internode length

____cm, 5. surface: a) glaucous, b) glabrous, c) hairy, d) spinules present, e) striate,

f) color, g) other _____

Number of Branches: 1. single, 2. two, 3. three,

4. multi-branching: a) with main branch, b) without main branch

Culm Sheath: 1.characteristics: a) persistent, b) caducous, c) deciduous d) other

2. texture: a) soft, b) hard, c) leathery, d) others _____

3. surface: a) glaucous, b) glabrous, c) hairy, d) spinules present and e) other _____

Sheath blade: 1. erect 2. horizontal 3. reflexed, 4. hairy _____

Leaf: 1. large, 2. medium, 3. small, 4. other (specify) _____

Uses: 1. shoot: a) sweet, b) bitter, c) fresh use, d) dry use, e) pickled shoot, f) sour shoot

2. building material: a) pillar, b) scaffolding, c) framework, d) wall or ceilings

3. weaving materials; 4. furniture; 5. agriculture tools, 6. ornamental, 7. medicine

8. music instrument, 9. folk belief, 10. other (specify) _____

Wood Quality Parameters: 1. strength: a) hard, b) soft, c) durable

2. elasticity: a) very good, b) good, c) poor, d) other (specify) _____

3. smoothness: a) smooth, b) rough, c) other _____

Market Potential: 1. very good, 3. good, 3. poor, 4. other _____

Remarks: _____

_____

Identification and examination of herbarium specimens.– Consultation and examination of herbarium materials of related bamboo species was conducted in various institutions and universities. The collected specimens were identified and examined based on folk classification and scientific taxonomic knowledge. An ethnobotanical inventory was carried out based on biosystematics and ethnobotany. The inventory included scientific names, vernacular names, uses, distribution, and voucher specimens, although the inventory is not included due to the space limitations of the paper.

FOLK CLASSIFICATION

It is common knowledge that when plants are utilized for any purpose, understanding their value and characteristics are very important. Folk classification has a very important role in the identification system of Yunnan's and China's minorities. In China, especially in the indigenous communities of Xishuangbanna, local people classify plants mainly based on local language, production practices, social customs, legends, economic utilization, morphological characteristics, and growth habits, which have very important economic and functional values (Wang and Hsueh 1990). Different ethnic communities may have different folk classification systems. For example, Hani people in Mengsong of Xishuangbanna use and recognize bamboo through traditional knowledge of bamboo habit, utilization and other characteristics. They understand the differences between erect and climbing bamboo. Erect bamboo is called ***Aq*** or ***Al*** (in Hani) as the first name, and climbing bamboo is called ***Haq***. Second, they give bamboo lower taxonomic rankings according to the morphological or utilization characteristics (Tables 2 and 3).

Dai folk classifications systems are more integrated and closer to Western science than the Hani system. For example, Dai people assign small-leaved *Dendrocalamus* spp. to the group ***Maisang***, glaucous-culmed ones to the group ***Maihe***, and group culmed striate *Gigantochloa* spp. to ***Maishua*** (Table 4). The Dai folk classification system of bamboo does not correspond exactly to Linnaeus' taxonomic system, but it is similar in the concepts of group, species and subspecies.

In comparison with scientific taxonomy, indigenous folk classification offers some important benefits. (1) Folk classification is often faster to use and simpler than the modern scientific taxonomy. Folk classification names a kind of bamboo

TABLE 2.– Folk classification of bamboo as related to use in Hani Communities of Mengsong, Xishuangbanna

Hani Name	Meanings	Bamboo Species
aqqyul	***qyul*** 'sweet', bamboo shoot is sweet	*Dendrocalamus hamiltonii*
alhaq	***haq*** 'bitter', bamboo shoot is bitter	Indosasa singulispicula
almal	***mal*** 'flute film', bamboo film used to make the bamboo flute	Phyllostachys mannii
aqmiov	***miov*** 'not seen'; it is said "a pig that eats this bamboo seed will die"	Cephalostachyum fuchsianum

TABLE 3.– Folk cassification of bamboo according to habit and character in Hani Communities of Mengsong, Xishuangbanna

Hani Name	Meanings	Botanical Name
aqpeel	***peel*** 'big': big bamboo	*Dendrocalamus giganteus*
aqbaol	***baol*** 'wild': wild bamboo	*Dendrocalamus* sp.
alnml	***lnml*** 'thorn': internodes have thorns, and young shoots are good, abundant and dense	*Chimonocalamus fimbriatus* var. *ligulatus*
alquq	***quq*** 'thorn': but the younger shoots grow sparsely	*Chimonobambusa yunnanensis* var. *glabra*
aqjul	***jul*** 'smooth': culm is smooth	*Dendrocalamus strictus*
aqljul	***ljul***: similar to ***jul***, but even smoother	*Fargesia* sp.
aqxao-aqlan	***xao*** 'stripe', ***lan*** 'grayish white': culm gray with stripe	*Gigantochloa nigrociliata*
aqxao-xeel	***xeel*** 'green': so culm green with stripe	*Dendrocalamus membranaceus* var. *striatus*
aqyeq	***yeq*** 'black': culm is black	*Dendrocalamus* sp.
haqgeeq(-mal)	***haq*** 'climbing', ***geeq*** 'wild': climbing bamboo with wide culm-node	*Melocalamus compactiflorus*
haggeq-aqzaoq	***aqzaoq*** 'narrow': climbing bamboo with narrow culm-node	*Melocalamus* sp. 1
haggeq-aqxeel	***aqxeel*** 'thin': climbing bamboo with thin culm-wall	*Melocalamus* sp. 2
Jeiqnav	bamboo shoot very dense and abundant	*Indosasa* sp.

based on direct observation and evaluative characteristics, whereas scientific classification often requires herbarium study. (2) The local name or folk classification can facilitate communication between local people and researchers. However, skilled ethnobotanists must know and understand the local names of related species, then use the names and morphological characteristics to match the folk taxon with a scientific name or names. (3) Folk names are often related to use, and to characteristics and first-hand experience. Folk classification can offer important clues to the exploitation of the resource by local people, and thus is useful for commercial and government planning, and to scientific researchers.

However, folk classification, in comparison with scientific classification, has a number of disadvantages. (1) Heterogeneity: similar bamboo species within a village or other villages may be referred to by different name (Table 5), or different bamboo species may be given a similar local name. (2) Limitation: bamboo folk classification, like all other forms of indigenous systems, has its limitations. Hani people divide bamboo into only two types: erect bamboo (***Aq*** or ***Al***) and climbing bamboo (***Haqgeeq***).

TABLE 4.– Group and individual names for bamboo species in a Dai Community

Group name	Individual Name	Bamboo Species
Maisang:*Dendrocalamus* spp. with smaller leaves	***Maisang***	*Dendrocalamus membranaceus*
	Maisanghe	*D. membranaceus f. fimbriligulatus*
	Maisanglai	*D. membranaceus f. striatus*
	Maisanghuan	*D. membranaceus f. crinitus*
	Maisanghai	*D. membranaceus f. bigemmatus*
	Maisangkou	*D. membranaceus f. pilosus*
	Maisangdaben	*D. membranaceus* var. *sulcatus*
	Maisanglan	*D. barbatus*
	Maisangbo	*D. albostriatus*
Maihe: *Dendrocalamus* spp. with glaucous or white haired culm.	***Maihegai***	*D. semiscandens*
	Maihelao	*D. brandisii*
	Maihelan	*D. brandisii f. hispiatus*
	Maihezhang	*D. hookeri*
	Maihelong	*D. hamiltonii* var. *serratus*
	Maihegaihao	*D. longiligulatus*
	Maihemen	*D. longiligulatus f. lacanus*
	Maihelaiqiu	*D. longiligulatus f. striatus*
Maishua: *Gigantochloa* spp., with striated culm	***Maishua***	*Gigantochloa nigrociliata*
	Maiheshua	*G. felix*
	Maishuahei	*G.* sp. 1
	Maishuanai	*G.* sp. 2

INDIGENOUS PROPAGATION PRACTICES

Cultivation of a number of bamboo species around houses, villages and fields is a tradition of many ethnic communities and individuals in Xishuangbanna. For example, the Hani families in Mengsong cultivate a large number of bamboos (Table 6, based on semi-structured interviews and sample questionnaire interviews). A local community usually prefers to plant bamboo and rattan together, because the bamboo supports the rattan. In recent years, ginger and tobacco have been intercropped with younger bamboo clumps for economic and ecological reasons.

Rooting of culm cuttings is traditionally used in propagating bamboo by ethnic communities of Xishuangbanna. However, Hani people in Mengsong commonly plant branch-cuttings of ***Aqqyul*** (*Dendrocalamus hamiltonii*) in swidden fields. They believe that this method results in slowing the growth of bamboo.

Bamboo plays an important role in the local economy. Table 7 shows economic statistics from the Menglong town government. Although these figures are not exact, they show the role of bamboo in indigenous communities. Other case studies have shown that bamboo and rattan together occupy the seventh position in the local economy based on semi-structured questionnaires (Wang 1998).

TABLE 5.– Names with translation, of *Indosasa singulispicula* in different ethnic communities.

Ethnic communities	Local Name	Meanings
Dai Commmunity	***Maihong***	***Mai*** 'bamboo', ***hong*** 'bitter'
Hani Community	***Alhaq***	***Al*** 'erect bamboo', ***haq*** 'bitter'
Aini Community	***Rahaq***	***Ra*** 'erect bamboo', ***haq*** 'bitter'
Yao Community	***Laoying-zhang***	***Lao*** 'bamboo', ***ying*** 'bitter', ***zhang*** 'small'
Kucong Community	***Wakada***	***Wa*** 'bamboo', ***ka*** 'bitter', ***da*** 'shoot'

TABLE 6.– The status of cultivation and utilization of bamboo in Mengsong Villages

Item sample	No. of groves per household	No. of species	No. of shoots/ groves/year	No. of culms used per household
1	20	6	17.5	75
2	9	3	-	-
3	12	4	10	75
4	30	4	20	30
5	20	4	20	50
6	20	5	25	100
7	17	5	5	25
8	25	4	12	60
9	25	4	10	75
10	10	6	10	50
11	10	4	15	50
12	150	6	20	100
13	35	3	3	100
14	40	50	15	100
15	10	5	10	50
16	50	4	20	100
17	80	6	20	50
18	7	3	8	35
19	100	5	10	50
20	15	5	20	40
21	10	5	10	35
22	18	5	10	20
23	8	4	10	45
24	9	5	8	50
25	6	2	10	20
26	50	5	15	50
27	20	5	18	100
28	30	5	30	100
29	100	4	25	50
30	45	6	10	225
31	10	3	10	20
Total	991	140	426.5	1993
Average	32	4.5	14.22	64.33

TABLE 7.– Statistics of bamboo production in Mengsong, Xishuangbanna

Year	No. of cut or harvested culms Large	Small	Dry shoots (kg)	No. of weaving products*	Total value (US$)
1985	71100	-	3792	648	53,192
1986	12920	-	3896	940	12,534
1987	13997	7550	3832	2035	18,130
1988	12920	7550	3896	970	15,182

* Note: Weaving products include a few rattan materials

CONSERVATION

Practices.– All ethnic communities in Xishuangbanna have a long tradition of planting, managing and conserving bamboo. Bamboo forests are classified into three types of property: national, community and family/individual bamboo forests. These are managed or protected by different agencies or individuals.

Based on the social, economic, cultural, and ecological surveys and studies, some efficient and reasonable management and conservation of bamboo genetic resources in Xishuangbanna are described below.

In-situ conservation.– Indigenous knowledge systems and national policies of China warrant the conservation of genetic resources of bamboo in China. Especially in minority areas, *in situ* conservation, through cultivation of bamboo plants among or along the village boundaries through establishment of bamboo gardens, and the maintenance of National Nature Reserves, are efficient methods of protecting and conserving the bamboo germplasm of China.

Community based conservation. Many bamboo species, naturally distributed and cultivated, are protected in community bamboo forests. These community forests are especially maintained by local religious or belief groups. ***Sangpabawa*** (the community protected forest in Hani communities), ***Nong Man*** or ***Nong Meng*** (community Holy Hills), ***Nong Ban*** (village Holy Hills in Dai ethnic groups), ***Ba Hao*** and ***Lao Ben*** (Graveyard forests, in Dai and Hani communities, respectively), ***Gai Mei San Ha*** (Water-source forests in Hani communities) are protected and well managed. There are also many Buddhist communities and Buddhist temples in Xishuangbanna that conserve bamboo resources. There are four requirements for establishing a temple (***Wa*** in Dai language) which are as follows: (a) a statue of Sakyamuni (Pagodama-Zhao, in Dai language), the founder of Buddhism, (b) a pagoda in which Sakyamuni's ashes can be preserved, (c) at least five monks, and (d) the presence of some specified "temple-yard plants" (Pei 1991). Based on these requirements, many plants have been cultivated inside the temple, some of which include bamboo species such as *Thyrsostachys siamensis, Bambusa sinospinosa, Dendrocalamus hamiltonii,* and *Phyllostachys mannii.*

Family/individual based conservation. Home gardens, bamboo gardens (***Aqpeya***, in Hani community), agroforestry practices, and swidden farming form a series of traditional systems for sustainable cultivation, management and conservation of bamboo resources. The bamboo clumps or forests belonging to every family are cut, managed, and conserved by the families. For example, the Dai people plant the multi-purpose bamboo species in the home garden or near the village,

and Hani people establish a bamboo garden (***Aqpeya***) or cultivate bamboo in the swidden system, and in ***Sangpabawa***.

In general, more valuable bamboo species, such as *Dendrocalamus giganteus, D. hamiltonii, D. barbatus, D. membranaceus, D. calostachyus, Indosasa singulispicula, Bambusa lapidea, Cephalostachyum pergracile,* and *Schizostachyum funghomii* are planted inside home gardens or bamboo gardens.

Swidden cultivation is practiced among all the mountain ethnic groups in the eastern Himalayan region. In Mengsong of Xishuangbanna, the Hani people have developed an agroforestry system. They cultivate bamboo in the swidden lands, and plant rattan using the bamboo clumps as support for the climbing rattan. Tobacco is intercropped among the bamboo clumps. The bamboo branch or culm is sometimes burned and the ash is used to fertilize tobacco. In other cases, bamboo is intercropped with maize, beans, vegetables and other crops in the agroforestry system of the Hani community of Mengsong. Short, medium and long-term income is obtained from the bamboo. The sloping swidden land is used for long-term agriculture products, thanks to the conservation of soil by the well developed roots-system of bamboo plants.

State conservation. National bamboo forests are grown and maintained in China's National Nature Reserves. These bamboo species, along with other conserved plants in the reserves, are protected from commercial activities.

Ex situ conservation.– Ethnobotanical information is considered useful to add to the information on collected plants in living-plant collections, seed-germplasm collections and herbarium collections. Data on vernacular (local) name of plants, indigenous uses of plants, ecological knowledge of plants, and local management practices of those plants are valuable. New information, which is generated from ethnobotanical expeditions, helps botanical gardens make plant lists for new collections (Pei 1994). In Yunnan and Xishuangbanna, the bamboo germplasm collection in the Xishuangbanna Tropical Botanic Garden is important for ex situ conservation of bamboo resources. According to this study, more than 100 species, varieties, and forms of bamboo belonging to 19 genera have been planted in this garden and are growing well.

Control of over-harvesting.– There are 91,800 ha of natural bamboo forests, or bamboo/tree mixed forests in Xishuangbanna that belong to the state, communities, and individuals (Wang and Hsueh 1992). These areas are managed and harvested (bamboo shoots and bamboo culms) to protect the watersheds and conserve bamboo gene pools. The traditional harvesting of bamboo shoots and culms from forest lands has been sustainable when these lands have been harvested for villager's home consumption, rather than for commercial purposes.

CONSERVATION ISSUES

Destruction of environment and natural habitat.– Destruction of the environment and natural habitat due to logging, shifting cultivation, and other land uses have led to the extinction of some bamboo species and depletion of bamboo forest resources.

In some parts of Xishuangbanna, shifting cultivation has primarily destroyed bamboo resources as a result of unscrupulous cutting of large areas of bamboo forest for agricultural land use (Wang and Hsueh 1992).

One conspicuous case of habitat destruction was the establishment of rubber plantations on more than 43% of Jinghong farms, which were previously natural bamboo forest or mixed bamboo/tree forests. Moreover, large bamboo areas have been converted to plantations of economic crops and plants, such as banana, coffee, tea, and fruit trees.

Over-exploitation and limited distribution.– In many cases, over-exploitation and lack of artificial propagation are threatening bamboo resources. For example, it is well known that the raw materials for papermaking, production of chopsticks and woven products in Xishuangbanna are supported only by the natural bamboo forests (Wang et al. 1993)

On the other hand, unreasonable and inefficient exploitation and utilization of bamboo resources have also led to the degeneration of natural bamboo stands. New emigrant workers who work for national farms or are employed by local people from Sichuan, Hunan and other provinces gather bamboo culms and shoots mostly from the natural bamboo forests. Insufficient knowledge on how to use and manage bamboo resources can lead to inefficient utilization and overexploitation. Rhizome cutting which deviates from the traditional methods of propagation, and culm cutting and shoot gathering by choosing only the large culms and stocky shoots, lead to the deterioration of bamboo species resources.

CONCLUSION

Indigenous knowledge concerning the identification, classification, nomenclature and conservation of bamboo plants have several important roles that are reviewed below.

Vernacular and scientific names.– The local plant nomenclature existed previously in oral tradition (Kelly and Dickinson 1985). Vernacular names of plant species are very important to plant resource inventories. They are based on indigenous people's productive practice, social customs, legends, and economic utilization. Habit and morphology of plants also have economic and functional significance. It should be noted, however, that sometimes those vernacular or local names are not considered very important for identifying bamboo because they are often not reliable. Therefore, great caution is required in the interpretation of vernacular names (Dransfield and Widjaja 1995).

Validity of folk classification.– There is a need to recognize the value and scientific validity of folk classification. Recognition and methods of use of plant resources by indigenous people are similar to those of the scientific world. For example, indigenous peoples classify plants, usually using morphological characteristics and physiological attributes, with consideration of their growing and reproductive habits.

Deep knowledge and utilization of indigenous knowledge.– It is important to recognize

that there is more detailed knowledge contained in some folk classification systems as compared to scientific classification. For example, local soil taxonomy of African farmers is based on soil characteristics as they relate to specific crops and, traditionally, provides the insight and ecological knowledge required for making good use of available agricultural resources (Richards 1985, cited in Dialla 1993). Dialla (1993) believes that the Mossi farmers classify soils in terms of cropping potential. The indigenous soil taxonomy may serve as a complementary tool to scientifically based systems, and a pragmatic soil classification allows Mossi farmers to make appropriate use of their land. Conklin (1954) concluded that plant names are significant to the Hanunoo (Mindoro Island of the Philippines), not only as convenient labels for recognized plant segregates but also for the semantic associations of the names employed. The application of traditional knowledge could substantially increase previous scientific information related to flora, fauna, and land use. The Hanunoo could identify approximately 1,600 different varieties of plants where systematic botanical survey had recorded only 1,200 species (Conklin 1957). This difference reflects the fact that the Hanunoo taxonomy employs different principles from those followed in Linnaeus' classification, grouping plants according to life form rather than in terms of genetic relationships (Rambo 1984). Similarly, Dai in Xishuangbanna divided a bamboo species (*Dendrocalamus membranaceus* Munro) into two types soft and hard types according to culm texture.

Conservation.– Indigenous knowledge or practices and indigenous communities have played a significant role for in situ conservation of bamboo resources. Home gardens, bamboo gardens and swidden cultivation systems demonstrate important conservation practices. In addition, recognition of the rights of local communities is a very important step in achieving the reasonable use, efficient conservation, and sustainable management of bamboo resources.

RECOMMENDATIONS

The following recommendations are made for future research and development.

Survey.– More interviews with indigenous communities and field surveys in other remote areas of China are necessary not only for species classification, identification and distribution of bamboo, but also to understand the cultural knowledge and uses of this important resource.

Conservation.– Plans and programs on the conservation of natural resource and cultural diversity should be prepared on a national scale, but with specific recommendation for each tribal group. Development plans should emphasize efficient conservation and sustainable exploitation of bamboo resources. The involvement and cooperation of different levels of beneficiaries is also necessary.

Dissemination of technology.– Some modern management methods and technologies can improve the efficiency of resource use, increase income to indigenous communities, and promote the improvement of well being in these communities.

It is therefore imperative to establish new systems that will link indigenous knowledge and modern technologies for more sustainable resource development. For example, improved/modern methods of bamboo propagation (e.g. culm cutting, branch cutting, and attendant silvicultural practices) may be introduced to the communities.

Financial support for in situ and ex situ conservation.– Conservation of bamboo genetic resources is very important for sustainable production in the future, but may be difficult due to the complexity of implementation strategies that may be affected by the diversity of resources, cultures, and financial incentives.

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